(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: 0 298 691 A2

(12) EUROPEAN PATENT APPLICATION

(21) Application number: 88306101.2

(22) Date of filing: 05.07.88

(51) Int. Cl.⁴: G11B 20/00 , G11B 20/10

(30) Priority: 08.07.87 JP 170248/87
08.07.87 JP 170249/87
21.09.87 JP 236527/87
15.12.87 JP 316635/87

(43) Date of publication of application: 11.01.89 Bulletin 89/02

(84) Designated Contracting States: DE FR GB NL

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(54) Method and apparatus for protection of signal copy.

(57) This invention relates to a method and apparatus for protection of signal copy for preventing unauthorized copy of music software such as record, compact disc and music tape by recording. More particularly, when manufacturing the music software, that is, when recording audio signals into the medium, certain supplemental information is added to the audio signal to be recorded, and in the process of copying by reproducing this medium, when the supplemental signal is detected in the reproduced signal, the copying action is stopped to protect from copy, so that the music software of which copy is prohibited is protected from being copied.

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Method and Apparatus for Protection of Signal Copy.

This invention relates to a method and apparatus for protection of signal copy intended to prevent unauthorized copy of music software such as record, compact disk (CD) and music tape by recording.

Recently, with the advent of DAT (Digital Audio Tape-recorder), it has come to be possible to copy the music software at high quality. To the contrary, the music software manufactures wish to introduce a system to prevent copy of music software by a recorder.

Formerly, as one of such systems, a copy code system disclosed by CBS was known. This system is described below.

In the manufacturing process of music software, that is, in the step of recording audio signals into a recording medium such as record, CD and music tape, the audio signals recorded in the recording medium is attenuated in the signal level in a specific band by a band elimination filter. The center frequency of this band elimination filter is 3840 Hz, and the band is 250 Hz.

In the process of recording by reproducing this recording medium, the reproduction signal is respectively fed into two band pass filters. The first band pass filter has the center frequency at 3840 Hz, and the second band pass filter, near 3840 Hz. Comparing the output amplitudes of these two band pass filters, when the first band pass filter is lower than the second band pass filter, it is judged that the signal level of a specific band is attenuated at the time of fabrication of the software, and the recording action is stopped. That is, by attenuating the signal in a specific band at the time of fabrication of the music software, copy by recording is prevented.

In such constitution, however, an inaudible sound is present for attenuating a specific band of audio signals, or the sound quality changes due to large variation of phase characteristic in the vicinity of the attenuation band of the band elimination filter. Or, in a music source originally small in the signal components of 3840 Hz, there was a possibility of malfunction. Thus, the conventional method has various problems.

It is hence a primary object of this invention to present a method and apparatus for protection of signal copy which is small in changes in sound quality due to attenuation of signal in specific band or is small in changes in phase characteristic, and is low in possibility of malfunction in any audio signal.

In order to achieve the above object, this invention comprises a supplemental information addition step for adding supplemental information to audio signals in the process of recording audio signals to a recording medium, and a detection step for detecting that said supplemental information is contained in a reproduced signal, and a copy protection step for preventing copy depending on the result of said detection step in the process for reproducing and copying said recording medium.

In this constitution, an audio signal for protecting from copy is recorded in the recording medium together with supplemental information, and when the supplemental information is detected in the reproduced signal in the process of reproducing and copying the recording medium, the copy action is prevented, so that a method and apparatus for protection of signal copy small in sound quality changes and malfunction may be realized.

Fig. 1 is a structural drawing of a signal copy protection apparatus in a first embodiment of this invention;

Fig. 2 is a detailed block diagram of a detector in Fig. 1;

Fig. 3 is an amplitude modulation waveform;

Fig. 4 is a structural drawing of an amplitude modulator;

Fig. 5 is a structural drawing of a modulated signal generator;

Fig. 6 is a structural drawing of a low cut filter;

Fig. 7 is a structural drawing of an automatic gain adjuster;

Fig. 8 is a structural drawing of a wave detector;

Fig. 9 is a structural drawing of a band pass filter;

Fig. 10 is a structural drawing of an amplitude detector;

Fig. 11 is a structural drawing of a copying machine;

Fig. 12 is a block diagram of a correlator used in a signal copy protection apparatus in a second embodiment of this invention;

Fig. 13 is a structural drawing of a signal copy protection apparatus in a third embodiment of this invention;

Fig. 14 is a detailed block diagram of a detector in Fig. 13;

Fig. 15 is a structural drawing of a band pass filter;

Fig. 16 is a structural drawing of a band elimination filter;

Fig. 1 shows the structure of a signal copy protection apparatus in a first embodiment of this invention, in which numeral 8 denotes an amplitude modulator, 4 is a recording medium, and 9 is a detector which controls a copy apparatus.

The operation of thus composed signal copy protection apparatus is described while referring to Fig. 1 to Fig. 11.

Fig. 2 is a detailed block diagram of a detector 9 in Fig. 1, and numeral 901 desnotes a low cut filter, 902 is an automatic gain adjuster, 903 is a wave detector, 904 is a band pass filter, and 905 is an amplitude detector.

In the audio signals to prohibit copy, amplitude modulation of a specified value is effected by an amplitude modulator 8 as shown in Fig. 3. A practical circuit composition of the amplitude modulator 8 is shown in Fig. 4 and Fig. 5. In Fig. 4, numerals 801 to 811 are resistors, 820 to 822 are capacitors, 827 to 834 are transistors, 838 is a variable resistor, and 10 are modulation signal generator, which are connected as shown in the drawing to make up a multiplier.

The audio signal is fed into one end of the capacitor 820, and is combined with the output of the modulation signal generator 10 to effect amplitude modulation, so that it is delivered to the output end of the capacitor 821 as modulation output. The degree of modulation is increased or decreased by the variable resistor 838.

The detail of the modulation signal generator is shown in Fig. 5, in which numerals 1012 to 1019 are resistors, 1023 to 1026 are capacitors, 1035 is a field effect transistor, 1036 is a diode, and 1037 is an operational amplifier, which are connected as shown to make up an oscillator by three-step feedback of resistors and capacitors. The oscillation frequency is about 10 Hz, and it is delivered from the output terminal of the operational amplifier 1037. The modulation frequency is a value outside the audible band for human ears, for example, 10 Hz, and the degree of modulation is similarly below the human detectable level, for example, 2%. When such modulation is effected, sound quality change is not detected at all. When it is attemped to duplicate into a copy medium 7 such as tape in the copy apparatus by reproducing audio signals from the recording medium or transmission medium such as disc, tape and broadcast wave containings such signals, the detector operates as described below.

First, the low frequency components originally present in the reproduction signals are removed by the low cut filter 901, and malfunction of the detector is prevented. Fig. 6 shows the structure of the low cut filter 901, in which numeral 9006 is a resistor, and 9007 is a capacitor, and a primary low cut filter is composed as shown in the drawing. The cutoff frequency is about 1 kHz. By keeping constant the amplitude of the reproduction signal by the automatic gain adjuster 902, the amplitude of the modulation signal is kept constant to be easily detected. The structure of the automatic gain adjuster 902 is shown in Fig. 7, in which numerals 9011 to 9020 are resistors, 9021 to 9025 are capacitors, 9027 is an operational amplifier, 9028 is a diode, and 9026 is an automatic gain adjusting amplifier. The response frequency is 1 Hz, lower than the frequency of modulation signal. The low-cut signal is fed into one end of capacitor 9021, and is set at constant gain, then is delivered from the output end of the operational amplifier 9027. The response speed of the automatic gain adjuster is, needless to say, set sufficiently slower than the period of the modulation frequency. Next, detecting this signal by the wave detector 903, the amplitude change

components are taken out. The composition of wave detector is shown in Fig. 8, in which numeral 9031 is a capacitor, 9032 is a resistor, and 9033 is a diode. In these amplitude change components, since there is a possibility of presence of echo or tremolo components originally contained in the audio signals, aside from the modulation signals, only the modulation signal components are taken out by the band pass filter 904. The structure of band pass filter 902 is shown in Fig. 9, in which numerals 9041 to 9045 are resistors, 9046 to 9049 are capacitors, and 9050 is an operational amplifier, which are combined to make up a twin T type band pass filter. Of the signals fed into one end of the capacitor 9046, only the 10 Hz components are delivered from the output terminal of the operational amplifier 9050. Finally, checking the amplitude of this modulation signal by the amplitude detector 905, if the degree of modulation is of specified value for a specified duration, it is judged as copy prohibition, and the detection signal is delivered, or the operation of the copy apparatus is stopped. The structure of the amplitude detector 905 is shown in Fig. 10, in which numerals 9061 to 9063 are resistors, 9064 is a variable resistor, 9065 is a level comparator, 9066 is a counter, and 9067 is an inverter, and when the amplitude of the signal fed into the input terminal of the variable resistor 9064 is outside the voltage range determined by resistances 9061 to 9063, the counter 9066 starts counting the clock CK fed into the clock terminal, and after lapse of a specified time the detection signal of high level is delivered from the output terminal RCO.

The structure of copy apparatus 6 is shown in Fig. 11, in which numeral 601 is a switch and 602 is a copying machine. When the detection signal which is an output of the amplitude detector 905 is at high level, the music signal is prevented from being fed into the copying machine.

Thus, according to the first embodiment, which comprises an amplitude modulator for amplitude-modulating the input signal, a recording medium for transmitting output signal of said amplitude modulator, a detector for detecting an amplitude modulation signal by detecting the output signal of said recording medium, and a copy apparatus for copying the output signal of said recording medium into a copying medium, said detector detects that the output signal of said recording medium is amplitude-modulated to a desired value, and delivers the detection signal or stops the operation of said copy apparatus, thereby specifying prohibition of copy depending on presence or absence of amplitude modulation. Therefore, degradation of the original audio signal does not occur, and the change in amplitude is kept under the human detectable limit by sufficiently reducing the degree of amplitude modulation, and erroneous detection can be prevented by properly selecting the frequency of modulation signal and degree of modulation.

In the first embodiment, meanwhile, a single-frequency signal was used as the modulation signal, but the same effects will be obtained by using arbitrary signals. In such a case, as the modulation signal detecting means, instead of the band pass filter, for example, a correlator may be used for extracting the features of the modulation signal.

A second embodiment of this invention is described below while referring to the accompanying drawings.

Fig. 12 is a block diagram of a correlator used in a signal copy protection apparatus showing the second embodiment of this invention, in which numeral 907 is a multiplier, and 908 is a modulation signal generator. What is different from the structure in Fig. 1 is that the band pass filter 904 in the detector 9 is replaced by the correlator 906 in Fig. 12. Aside from this correlation, the structure is identical with that shown in Fig. 1 and Fig. 2, and the explanation is omitted, and only the operation of the correlator is described below.

A same signal as the modulation signal used in the amplitude modulator 8 is generated by the modulation signal generator 908, and it is combined with the input signal in the multiplier 907, and the product is sent to the amplitude detector 905. The construction of the multiplier 907 is shown in Fig. 4. The structure of the modulation signal generator 908 is same as that of the noise generating means in Fig. 19. In the case of the second embodiment, needless to say, the part expressed by numeral 908 is used as the modulation signal generator in the amplitude modulator 8. Among the input signals of the correlator 906, if there is a same component as the modulation signal and their phases are matched, the output of the multiplier 907 becomes high level. Therefore, in the correlator 906, the phase of the output signal of the modulation signal generator 908 is shifted in every specified time to check for presence or absence of correlation.

When the output signal level of the correlator 906 is kept at a specified level for a specified time, needless to say, the amplitude detector 905 delivers a detection signal or stops the action of the copy apparatus 6.

Thus, by installing a correlator instead of the band pass filter, an arbitrary signal may be used as modulation signal, and erroneous detection may be prevented more reliably.

In the first embodiment, the automatic gain adjuster 902 was placed after the low pass filter 901, but it

may be also placed before it, or after the wave detector 903 or after the band pass filter 904.

This invention is, therefore, intended to prohibit copy by presence or absence of amplitude modulation signal by installing an amplitude modulator and its detector, and hence dropout of the original music signal does not occur, and the amplitude change may be kept below the human detectable limit by sufficiently reducing the degree of amplitude modulation, and erroneous detection may be prevented by properly selecting the amplitude signal.

Fig. 13 shows the structure of a signal copy protection apparatus in a third embodiment of this invention, in which numerals 4, 6 to 9 are identical with those in the first embodiment, of which details are shown in Figs. 4 to 11. Numeral 11 is a band pass filter, and 12 is a band elimination filter; after the outputs of the both are added in an adder 13, the sum is sent into a recording medium 4.

The operation of thus composed signal copy protection apparatus is described below while referring to Figs. 13 to 17.

Fig. 14 is a detailed block diagram of the detector 9 in Fig. 13, and the composition is same as in the first embodiment except that numeral 909 is a first band pass filter. The music signal of which copy should be prohibited is combined with a signal outside a specified frequency band taken out by the band elimination filter 12 after taking out a specified frequency band, for example, only the components around 1 kHz as shown in Fig. 3 by means of the band pass filter 11 and amplitude-modulating with a specified value by the amplitude modulator 8. As a result, a signal amplitude-modulated only in a specified frequency is obtained.

A detailed structure of the band pass filter 11 is shown in Fig. 15, in which numerals 1101 to 1105 are resistors, 1107 to 1110 are capacitors, and 1111 is an operational amplifier, which are combined to make up a same twin T type band pass filter as in the first embodiment shown in Fig. 9. However, the passing band is 1 kHz.

A detailed structure of the band elimination filter 12 is shown in Fig. 16, in which numerals 1201 to 1205 are resistors, 1206 to 1208 are capacitors, and 1209 is an operational amplifier, which are combined to make up a twin T type band elimination filter. The elimination band is also 1 kHz.

The structure of the adder 13 is shown in Fig. 17, in which numerals 1301 to 1303 are resistors, 1304 is a variable resistor, and 1305 is an operational amplifier, and an input signal is added to one end of the variable resistor 1304 and one end of the resistor 1301, and is delivered to the output terminal of the operational amplifier 1305. The addition level can be adjusted by the variable resistor 1304.

The modulation frequency is outside the human audible range, for example, 10 Hz, and the degree of modulation is similarly below the human detectable level, for example, 2%. By such modulation, change in the sound quality cannot be sensed at all. When it is attemped to duplicate from recording medium or transmission medium such as disc, tape and broadcast wave containing such signal in a copy medium 7 such as tape by a copy apparatus 6 by reproducing music signal, the detector functions as follows.

From the music signal, the amplitude-modulated frequency component is taken out by the first band pass filter 909, and is set at a specified amplitude by means of the automatic gain adjuster 902, so that the amplitude of the modulation signal is set constant for the ease of detection. The composition of the first band pass filter is same as that shown in Fig. 15. The operation after the automatic gain adjuster 902 is same as in the first embodiment and is omitted here.

Thus, according to this embodiment, which comprises a band pass filter for amplitude-modulating only a specific frequency component of input signal, a band elimination filter, an amplitude modulator, a recording medium for transmitting the output signal of said amplitude modulator, a detector for detecting the amplitude modulation signal by searching the output signal of said recording medium, and a copy apparatus for copying the output signal of said recording medium into a copy medium, since prohibition of copy is specified by presence or absence of amplitude modulation by delivering the detection signal or stopping the action of the copy apparatus when the detector detects that the output signal of the recording medium is amplitude-modulated to a specified value, dropout of the original music signal does not occur, and the change in amplitude may be kept under the human detectable limit by sufficiently reducing the degree of amplitude modulation, and also erroneous detection can be prevented by properly selecting the frequency of modulation signal and degree of modulation. Furthermore, by amplitude-modulating only the specific frequency component, deterioration of sound quality of the original music signal may be kept to a minimum.

In the third embodiment, incidentally, a single-frequency signal was used as modulation signal, but an arbitrary signal may be also used. In this case, instead of the band pass filter as the means for detection of modulation signal, for example, a correlator as shown in Fig. 12 may be used for extracting the features of the modulation signal.

By installing a correlator instead of the band pass filter, it is possible to use an arbitrary signal as

modulation signal, and erroneous detection may be prevented more reliably.

This invention is thus intended to specify prohibition of copy depending on presence or absence of amplitude modulation signal by installing an amplitude modulator and its detector, and therefore, degradation of the original music signal does not occur and the change in amplitude may be kept under the human detectable limit by sufficiently reducing the degree of amplitude modulation, and also erroneous detection may be prevented by properly selecting a modulation signal. Moreover, by amplitude-modulating only a specific frequency component, a deterioration of the sound quality of the original music signal may be kept to a minimum.

Fig. 18 is a block diagram of a signal copy protection apparatus in a fourth embodiment of this invention, in which (a) denotes a step of recording audio signal in a recording medium, 1 is an audio signal, 2 is an addition means, 14 is a noise generating means, 3 is a recording means of recording medium, 4 is a recording medium, (b) denotes a step of reproducing and copying the recording medium, 5 is a reproducing means of the recording medium, 6 is a copy means, 15 is a detection means, and 7 is a copy medium.

The operation of thus composed signal copy protection apparatus is described below while referring to Figs. 18 to 23.

First is described the step of manufacturing music software, that is, the step of recording audio signal into a recording medium such as record, CD, and music tape. The input audio signal is combined with a noise signal 141 by the addition means. The noise signal 141 is obtained by the noise generating means 14. The audio signal combined with the noise signal is recorded into the recording medium by the recording means 3.

Fig. 19 is a circuit diagram of noise generating means 14 and addition means 2, in which numeral 1401 is a clock signal generating circuit, 1402 is a counter, 1403 is a ROM, 1404 is a D/A converter, 1410 to 1411 are resistors, 1412 to 1413 are capacitors, 1414 is an operational amplifier, 2001 to 2003 are resistors, and 2004 is an operational amplifier. The noise generating means 14 generates a noise signal by reading out the noise waveform stored in the ROM 1403. The capacity of the ROM 1403 is 2^{12}-1 words, and the width of the output data is 12 bits. The counter 1402 works on the notation of 2^{12}-1, and counts the clock pulses obtained from the clock generating circuit 1401, and generates an address of the ROM 1403. The clock frequency delivered by the clock generating circuit 1401 is 44.1 kHz, and this value becomes the sampling frequency of the noise waveform delivered by the ROM 1403. The noise waveform delivered from the ROM 1403 is converted into an analog signal by the 12-bit D/A converter 1404, and becomes a noise signal 141 after the repetitive component due to sampling is removed by the low pass filter composed of operational amplifier 1414. The low pass filter is of secondary Butterworth type, and the cutoff frequency is about 20 kHz. Since the noise signal is generated by repetitively reading out the noise waveform stored in the ROM, it is not perfectly random but is cyclic. The cycle of the noise signal is about 93 ms because the sampling frequency is 44.1 KHz and the counter 1402 is of notation of 2^{12}-1. The characteristic of the noise signal is determined by the data stored in the ROM 1403. The equivalent circuit of the noise generating means 14 is shown in Fig. 20, in which numeral 1420 is an M-sequence generating circuit, 1421 to 1432 are D-type flip-flops, and 1433 to 1435 are EX-ORs. The signals simultaneously taken out from the outputs Q of 12 D-type flip-flops of the M-sequence generating circuit 1420 posses the characteristics similar to those of white noise. That is, the noise signal contains all frequency components. However, when such noise signal is added to the audio signal, the noise is easily audible, and therefore, the noise signal is once passed through the digital filter 1440 to be limited in a band to which human ear has low sensitivity. The frequency characteristics of the digital filter 1440 are showing in Fig. 21. By passing the output signal of the M-sequence generating circuit through the digital filter 1440, the frequency components of the noise signal are limited within 10 kHz to 20 kHz. The input signal of the digital filter 1440 is a repetitive pattern of 2^{12}-1 pieces of data, and therefore, the output signal is also a repetitive pattern of 2^{12}-1 pieces of data. By storing the output pattern of the digital filter 1440 into the ROM and reading it out, the circuit of the noise generating means 14 may be greatly simplified. The ROM 1403 in Fig. 19 is designed in this principle.

The addition means 2 is composed of operational amplifier 204, and the noise signal 141 and audio signal 1 are added up, and a recording signal 21 is obtained.

The recording means 3 of the recording medium is, for example if the recording medium is a record, related to the manufacturing process of record, including from the cutting to pressing of the record disc.

The step of reproducing and copying the recording medium is described below. The reproduction signal 51 reproduced from the recording medium 4 by the reproducing means 5 is fed into the copying means 6 and detecting means 15. When the detecting means 15 detects that the noise signal 141 is contained in the reproduction signal, the detection signal 151 is set to high level. The copying means 6 duplicates the reproduction signal 51 into the copying medium 7. This action, however, is stopped when the

detection signal 151 is high level.

The reproducing means 6 of the recording medium is, for example if the recording medium is a record, a record reproducing system composed of record player and audio amplifier.

Fig. 22 is a circuit diagram of the detecting means 15, in which numeral 1501 is a low pass filter, 1502 to 1503 are resistors, 1504 to 1505 are capacitors, 1506 is an operational amplifier, 1510 is a sample hold circuit, 1501 is a capacitor, 1502 is a sample chold IC, 1520 is an A/D converter, 1530 is a noise generating circuit, 1531 is a clock generating circuit, 1532 is a counter, 1533 is a ROM, and 1540 is a microprocessor.

The noise generating circuit 1530 is the noise generating means 14 minus D/A converter and low pass filter. The clock generating circuit 1531 generates a clock signal CLK of 44.1 kHz. The counter 1532 and ROM 1533 are respectively same as the counter 1402 and ROM 1403. Therefore, the output data of the ROM 1402 and ROM 1533 are identical in pattern. The sampling frequency of the noise signal 152 which is the output of ROM 1533 is 44.1 kHz. The reproduction signal 51 fed into the detecting means 15 passes through the low pass filter 1501 and sample hold circuit 1510, and is quantized in the 16-bit A/D converter 1520. The sample pulse of the sample hold circuit uses the clock signal CLK, and the sampling frequency of the sampled reproduction signal 153 is 44.1 kHz. The microprocessor 1540 determines the cross-correlation function of the noise signal 152 and the sampled reproduction signal 153. Supposing the reproduction signal to be f1(t) and the noise signal to be f2(t), the cross-correlation function $\phi(\tau)$ of f1(t) and f2(5) may be expressed in equation (1).

$$\Phi(\tau) = \frac{1}{M} \sum_{k=0}^{M-1} f1(k) \cdot f2(k+\tau) \quad \cdots (1)$$

The microprocessor 1540 operates the calculation of equation (1). If the noise signal 141 is contained in the reproduction signal, the cross-correlation function has the peak in the cycle Tm as shown in Fig. 23. Tm is equal to the cycle of the noise signals 141 and 152. When the microprocessor 1540 detects the peak in Fig. 23 in the cross-correlation function, the detection signal 151 is set to high level. This detection means 15 is contained in the same structure ad the copying means 6.

The copying means 6 is, if the copying medium is a digital audio tape, a digital audio taperecorder. The detection signal 151 is fed into the microprocessor for control of the digital audio taperecorder, and when this signal becomes high level, the recording action is stopped.

Thus, according to this embodiment, since the noise signal is added to the audio signal when recording the audio signal into the recording medium and copy of the recording medium is prohibited when the noise signal is detected in the reproduction signal at the time of copying by reproducing this recording medium, the recording medium of which reproduction is prohibited is protected from being copied by the copy apparatus. Here, the noise signal added to the audio signal is not perfectly random, but is a cyclic waveform repeating the same pattern, and therefore, when the same noise signal is generated by the detecting means and the cross-correlation function between this noise signal and the reproduction signal is evaluated, presence of noise signal in the reproduction signal can be detected. If the amplitude of the noise signal added to the audio signal is small, the noise does not matter when the recorded signal is reproduced. Besides, since the specific band of the audio signal is not attenuated, there is no effect on the sound quality.

Fig. 24 (a) shows a block diagram of a copy code encoder in a signal copy protection apparatus in a fifth embodiment of this invention, in which numeral 16 is a delaying device, 17 is an amplifier and 2 is an adder. The audio signal is delayed by T seconds by the delaying device 16. This output is amplified K times by the amplifier 17, where K is a positive value smaller than 1. This output is combined with the audio signal in the adder 2, thus the copy code is encoded. This output becomes a record signal.

Fig. 24 (b) shows a block diagram of a copy code detector in the signal copy protection apparatus of a fifth embodiment of this invention, in which numeral 18 is a low elimination filter, 19 is a normalizing auto-correlation function calculator, 20 is a maximum function calculator, 21 is a mean function calculator, and 22 is a level difference discriminator. The audio signal is passed through the low cut filter 18. This is intended to reduce the portion other than $\tau = 0$ of the auto-correlation function $R(\tau)$ to be used in a later process. Next, the normalizing auto-correlation function $R(\tau)$ is calculated by the normalizing auto-correlation function calculator 19. This calculation method is described below. The output of the filter 18 is supposed to be A(t). An audio signal without copy code is supposed to be a(t). The auto-correlation function of a(t) is supposed to be $r(\tau)$. Besides, t is supposed to be a discrete value. Hence we obtain:

$$\therefore r(\tau) \equiv \frac{1}{N}\sum_{t=0}^{N-\tau-1} a(t)\cdot a(t+\tau) \qquad \cdots\cdots(2)$$

When N is a length of the interval of the auto-correlation.

$$R(\tau) = \frac{\frac{1}{N}\sum_{t=0}^{N-\tau-1} A(t)\cdot A(t+\tau)}{\frac{1}{N}\sum_{t=0}^{N-1}\{A(t)\}^2} \qquad \cdots\cdots(3)$$

where τ is sufficiently smaller than N.

If A(t) = a(t), then

$$R(\tau) = \frac{r(\tau)}{r(0)} \equiv r_N(\tau) \qquad \cdots\cdots(4)$$

This relation is shown in Fig. 25, in which the axis of ordinates denotes $R(\tau)$, and the axis of abscissas represents τ. The solid-line curve refers to $R(\tau)$.

If the audio signal contains the copy code, the operation is as follows.

At this time, we obtain

$A(t) = a(t) + k \cdot a(t - T)$ (5)

If A(t) is ergodic, it follows that

$$\begin{aligned}&\frac{1}{N}\sum_{t=0}^{N-\tau-1} A(t)\cdot A(t+\tau)\\&=(1+k^2)\cdot r(\tau)\\&\quad +k\{r(\tau+T)+r(\tau-T)\}\end{aligned} \qquad \cdots\cdots(6)$$

$$\therefore R(\tau) = \frac{r_N(\tau)+\frac{K}{1+K^2}\{r_N(\tau-T)+r_N(\tau+T)\}}{1+\frac{2K}{1+K^2}\cdot r_N(T)} \qquad \cdots\cdots(7)$$

$K << 1$, $|r_N(\tau)| \leq 1$, then

$R(\tau) \fallingdotseq r_N(\tau) + K\{r_N(\tau - T) + r_N(\tau + T)\}$ (8)

The second term of equation (8) is the effect of the copy code.

When τ = T or τ = -T, we obtain:

$R(\tau) \cong r_N(T) + k$ (9)

The effect due to copy code is indicated by dotted line in Fig. 25. The relations are $\Delta T_1 < \Delta T_3$, $\Delta T_2 < T_4$. These are smaller values than T.

An example of construction of the normalizing auto-correlation function calculator 19 is shown in Fig. 26, in which numeral 1902 is a multiplier A, 1903 is a multiplier B, 1904 is an adder A, 1095 is an adder B, 1906 is a counter A, 1907 is a register A, 1908 is a register B, 1909 is a counter B, 1910 is a devider, and 1911 is a memory. The delaying device 1901 has a delay time of τ. The input signal and its output after passing through the delaying device 1901 are fed into the multiplier B 1903, and the produce is obtained. Similarly, a square produce of the input signal is obtained in the multiplier A 1902. The output of the multiplier B 1903 is the a-input of the adder B 1905. This output is fed into the register B 1908. The register B 1908 is controlled by the counter B 1909. That is, the content of the register B is cleared in the first place. The counter B counts (N-τ) times, and it counts every time a sample comes to the register B to permit it to be stored in the register B. After counting (N-τ) times, the counting action is stopped, and the register B 1908 is not updated. The b-input of the adder B 1905 is the content of the register B 1908. In this way, the sum of the sample values of (N-τ) times of the outputs of the multiplier B 1903 is obtained at the output of the register B 1908. On the other hand, the output of the multiplier A 1902 is the a-input of the adder A 1904. This output is fed into the register A 1907. The register A is controlled by the counter A 1906. That is, the content of the register A is cleared at the beginning. The counter A is to count N times, and counts every time a sample comes to the register to permit it to be stored in the register A. After counting N times, the counting action is stopped, and the register A 1907 is not updated. The b-input of the adder A 1904 is the content of the register A 1907. In this way, the sum of sample values of N times of the outputs of the multiplier A 1902 is obtained at the output of the register A 1907. In the divider 1910, the content of the register B is divided by the content of the register A. This result is stored in the memory 1911. Afterwards, the contents of the counter A, counter B, register A, and register B are cleared, and the value of τ is changed, and the same operation is repeated. As the value of τ, meanwhile, any value between $T - \Delta T_3$ and $T + \Delta T_4$ is taken.

The maximum function calculator 20 calculates the maximum value of $R(\tau)$ in the relation of $T-\Delta T_1 \leqq \tau \leqq T+\Delta T_2$.

The mean function calculator 7 calculates the mean of $R(\tau)$ in the relations of $T-\Delta T_3 \leqq \tau \leqq T-\Delta T_1$ and $T+\Delta T_2 \leqq \tau \leqq T+\Delta T_4$.

The level difference discriminator 22 subtracts the output of the calculator 21 from the output of the calculator 20, and checks if the result is somewhere between $k-\Delta k_1$ and $k+\Delta k_2$, where Δk_1 and Δk_2 are smaller than k. If within this range, it is judged that the copy code is present, and otherwise it is judged that there is no copy code. This result is delivered.

According to this embodiment, as clear from the description hereabove, serious deterioration of the sound quality may be avoided by encoding by using a slight echo component as the copy code.

In Fig. 24 (a), meanwhile, one delaying device 16 and one amplifier 17 are used, but plural sets thereof may be installed parallel. In this case, at the detector side, plural sets of calculator 20, calculator 21 and discriminator 22 must be used. But the principle is exactly the same as in this embodiment.

Or an equivalent of a filter 18 may be placed in series to the delaying device 16 and amplifier 17. The sound quality may vary somewhat, but the detector output is not changed. As the filter 18, a band pass filter or a high pass filter may be used.

In this invention, therefore, a signal copy protection apparatus small in deterioration of sound quality may be composed by installing delaying device, amplifier and adder as the copy code encoder, and using normalizing auto-correlation function calculator as the copy code detector.

Fig. 27 is a block diagram of a copy code detector of a signal copy protection apparatus in a sixth embodiment of this invention. What is different from the fifth embodiment is that a fixed threshold value th is used instead of installing the maximum function calculator. The effect of the copy code is indicated by broken line in Fig. 28. In an ordinary audio signal without copy code, the threshold th is set at a level which cannot be reached by R(T). That is,

$R(T) = r_N(T) < th$

However, if there is a copy code, in order that R(T) may exceed th, the value of th is set in the relation of

$th < R(T) \cong r_N(T) + K$

Here, the construction of the normalizing auto-correlation function calculator 19 is as shown in Fig. 23. In the level discriminator 23, R(T) and threshold th are compared, and when R(T) is greater than th, the result of presence of copy code is delivered, and when R(T) is smaller than th, the result of absence of copy code is delivered.

In this embodiment, thus, by encoding by using a slight echo component as the copy code, serious deterioration of sound quality may be avoided.

This invention hence can compose a signal copy protection apparatus small in deterioration of sound quality by installing delaying device, amplifier and adder as the copy code encoder, and using normalizing auto-correlation function calculator as the copy code detector.

A signal copy protection system in a seventh embodiment of this invention is described below while referring to the accompanying drawings. Fig. 29 shows the constitution of signal copy protection system in the seventh embodiment of this invention, in which numeral 24 is a keyed information, 25 is a detecting means, 6 is a copying means, and 26 is a copying battery, and the detecting means 25 controls the action of the copying means by the state of the copying battery 26.

The operation of thus composed signal copy protection system is described below by reference to Figs. 29 to 32. Fig. 30 is a detailed drawing of the copying battery.

First, the information of which copyright must be protected is locked with a key by a certain method. To lock with a key, a special signal is added to the information as shown in the methods in the embodiments in Figs. 1, 13, 18, 24. When it is attemped to duplicate such keyed information into a copying medium such as tape by the copying means through the recording medium or transmission medium such as disc, tape and broadcast wave, the detecting means 25 operates as follows.

At the beginning, when the detecting means 25 detects that the input information 24 is locked with a key, it is checked that the copying battery 26 is connected, and only when the electric power is supplied from both the copying battery 26 and the power source, the operation of the copying means 6 is enabled, and the electric power proportional to the copied information is subtracted from said copying battery.

Fig. 31 shows a detailed structure of the detecting means, in which numerals 2501 to 2503 are resistors, 2504 is a switch, 2505 is a level comparator, and 2506 is a detector. The composition of the detector 2506 is same as that explained in the embodiment in Figs. 2, 14, 22, 24 and 27.

Locking of the information with a key is detected by the detector 2506, and the high level detection signal closes the switch 2504 connected to the copying battery 2601. As a result, the electric power of the battery 2601 is consumed through the resistor 2503, and while its voltage is higher than the value set by the resistors 2501 and 2502, the output signal of the level comparator 2505 maintains a low level, and the switch 601 in the copying means 6 of which detail is shown in Fig. 11 is closed, and the information is sent into the copying device 602.

Since the copying battery 2601 is a cell reserving a limited electric power, and when its electric power is used up, the power can be no longer supplied, and the copy is interrupted.

Furthermore, the copying battery may be a virtual cell which stores the initial electric power quantity proportional to the copyright fee paid at the time of its purchase in the form of information.

A detailed structure of a virtual cell is shown in Fig. 32, in which numeral 2602 is a read only memory which can be written electrically (EEPROM), and 2603 is a microcomputer.

In this case, too, the copying means 6 does not operate unless it is used. When the virtual cell is used, the microcomputer 2603 supplies a copy permit signal outside as an electric power, and the copied information quantity is calculated from the time of the duration of high level of detection signal, and the balance of quantity of electric power from which its proportional value is subtracted is stored again in the EEPROM 2602. When the stored value becomes zero, the microcomputer 2603 stops the supply of electric power outside. That is, the output of the copy permit signal is stopped. Therefore, the detecting means 25 stops the action of the copying means 6.

Thus, according to the seventh embodiment of this invention, which comprises the keyed information, the detecting means for detecting locking of information with a key, the copying battery for reserving a limited electric power, and the copying means for copying the information, in a manner to control the copying means by the detector depending on the battery state, even the keyed information can be copied only if the copying battery is available, so that the wide use of the useful information in the society is encouraged, while the copyright owner and the user can both enjoy merits. Besides, if the unkeyed information is misunderstood as keyed information due to malfunction, only the electric power reserved in the copying battery is consumed, and that information is not prohibited of copy.

In the seventh embodiment, meanwhile, the copying battery is assumed to be a virtual cell reserving the initial electric power proportional to the copyright fee paid at the time of purchase in the form of information, but this is not limitative, and it may be composed of a finite number of unerasable memories as described below. In this case, instead of the electrically writable memory 2602 shown in Fig. 32, an unerasable memory (fuse ROM) is used, and when the microcomputer 2603 in the virtual cell 26 write a specified value into the memory 2602 by the number of times proportional to the quantity of copied information and detects that specified value is written in all memory regions, a low level copy permit signal

is sent into the detecting means 25. The detecting means 25 receiving it sends a high level copy prohibition signal to the copying means 6, and the copying means 6 stops the copying action.

Fig. 33 shows a detailed structure of a detecting means in an eighth embodiment of this invention, in which numeral 2506 is a detector shown in the embodiments in Figs. 2, 14, 19, 24, and 27, 2507 is an inverter, and 2508 is an AND circuit. When the key is detected by the detector 2506, the detector 2506 feeds a high level detection signal to the AND circuit 2508 and the microcomputer 2603 in the copying battery 26. As far as a high level copy permit signal is supplied from the microcomputer 2603 into the inverter 2507, the output of the inverter 2507 is low level, and therefore, the output of the AND circuit 2508 supplies the low level copy prohibition signal into the switch 601 in the copying means 6, so that copy is effected.

When the copy permit signal becomes low level, the output of the inverter 2507 becomes high lever, and as far as the detector 2506 detects the key and is delivering the high level detection signal, the output of the AND 2508, that is, the copy prohibition signal is high level, and the copying means 6 stops copy.

Furthermore, the copying battery may be a terminal machine of a bank online system, and the amount proportional to the quantity of copied information may be automatically subtracted from the account of the user to pay to the copyright owner.

In this case, the microcomputer 2603 shown in Fig. 32 is the online terminal, and the memory 2602 is the host computer in which the account is registered, and the above operation is effected.

Accordingly, in this invention, comprising the keyed information, the detecting means for detecting the locking of the information with the key, the copying battery for reserving a limited electric power, and the copying means for copying said information, when the detecting means detects that the input information in the copying means is locked with the key, the action of the copying means is enabled only if the electric power is supplied from both the copying battery and the power source, and the electric power proportional to the quantity of copied information is sub tracted from the copying battery, which allows to duplicate the information if locked with key as far as the copying battery is available, so that the wide use of useful information in the society is encouraged, while the copyright owner and the user both enjoy the merit. Or even when an unkeyed information is misjudged to be keyed information by erroneous action, only the electric power reserved in the copying battery is consumed, but the information is not prohibited of copy.

Claims

1. A signal copy protection method for protecting a signal reproduced from a recording medium from being copied, comprising: a supplemental information addition step for adding supplemental information to an audio signal in a process of recording the audio signal in a recording medium; a detection step for detecting the presence of said supplemental information in the reproduced signal; and a copy protection step for preventing unauthorized copy depending on the result of said detection step in the process of reproducing the recorded signal.

2. A signal copy protection apparatus comprising an amplitude modulator for amplitude-modulating an input signal; a recording medium for transmitting an output signal of said amplitude modulator; a detector for detecting the amplitude-modulated signal by searching an output signal of said recording medium; and a copying device for copying the output signal from said recording medium, wherein said detector detects that the output signal of said recording medium is amplitude-modulated in a specified value, and delivers the detection signal or stops the action of said copying device.

3. The signal copy protection apparatus as defined in claim 2, wherein the detector comprises a low cut filter for removing the low frequency components in the output signal from the recording medium, an automatic gain adjuster for setting the amplitude of output signal of said low cut filter at a specified valve, a wave detector for detecting the output signal adjusted in said specified amplitude, a band pass filter for taking out a specified amplitude-modulated signal from the output of said wave detector, and an amplitude detector for detecting duration of said amplitude-modulated signal over a specified time at a specified amplitude.

4. The signal copy protection apparatus as defined in claim 2, wherein the detector comprises a low cut filter for removing the low frequency component in the output signal from the recording medium, an automatic gain adjuster for setting the amplitude of output signal of said low cut filter at a specified value, a wave detector for rectifying the output signal adjusted in said specified amplitude, a correlator for detecting a specified amplitude-modulated signal from the output of said wave detector, and an amplitude detector for detecting duration of the output signal of said correlator for a specified time.

5. A signal copy protection apparatus comprising a band pass filter for taking out signals of only a specific frequency band from input signals, an amplitude modulator for amplitude-modulating the output signal of said band pass filter, a band elimination filter for removing only a signal of said specified frequency band connected parallel to said band pass filter and amplitude modulator, a recording medium for transmitting a sum signal of an output of said amplitude modulator and an output of said band elimination filter, a detector for detecting the amplitude modulation signal by searching the output signal of said recording medium, and a copying device for copying an output signal of said recording medium, wherein the detector detects that the output signal of said recording medium is amplitude-modulated in a specified value, and delivers a detection signal or stops the action of said copying device.

6. The signal copy protection apparatus as defined in claim 5, wherein the detector comprises a first band pass filter for extracting specific frequency components in the output signal from the recording medium, an automatic gain adjuster for setting the amplitude of the output signal of said first band pass filter at a specified value, a wave detector for detecting the output signal adjusted in said specified amplitude, a second band pass filter for taking out specified amplitude-modulated signal from an output of said wave detector, and an amplitude detector for detecting the duration of said amplitude-modulated signal for a specified time at specified amplitude.

7. The signal copy protection apparatus as defined in claim 5, wherein the detector comprises a first band pass filter for extracting specific frequency components in the output signal from the recording medium, an automatic gain adjuster for setting the amplitude of output signal of said first band pass filter at a specified value, a wave detector for detecting the output signal adjusted in said specified amplitude, a correlator for detecting the specified amplitude-modulated signal from the output of said wave detector, and an amplitude detector for detecting duration of the output signal of said correlator for a specified time.

8. A signal copy protection apparatus comprising: signal generating means for generating dummy noise having a periodicity, addition means for adding said dummy noise to an input signal, recording means for recording an output of said addition means in a recording medium, detecting means for detecting the presence of said dummy noise in a reproduced signal and copy protection means for protecting from copying when said detecting means detects the dummy noise.

9. The signal copy protection apparatus as defined in claim 8, wherein the dummy noise is generated by a maximum sequence.

10. The signal copy protection apparatus as defined in claim 8, wherein the dummy signal is obtained by limiting the band of the signal generated by a maximum sequence.

11. A signal copy protection apparatus having a copy code encoder comprising echo signal generating means composed of a delaying device for delaying an audio original signal and an amplifier, and an adder for adding an output of said means and the original audio signal.

12. The signal copy protection apparatus as defined in claim 11, further having a copy code detector comprising a low cut filter for receiving audio signal, a normalizing auto-correlation function calculator for receiving its output, a maximum function calculator and a mean function calculator for receiving its output, and a level difference discriminator for discriminating a level difference between the output of said maximum function calculator and the output of said mean function calculator.

13. A signal copy protection apparatus comprising a copy code encoder which comprises echo signal generating means composed of a delaying device for receiving audio original signal and an amplifier, and an adder for receiving said means output and said audio original signal; and a copy code detector which comprises a low frequency component removing filter for receiving said audio signal, a normalizing self-correlation function calculator for receiving its output, and a level discriminator for receiving its output and threshold.

14. A signal copy protection method comprising keyed information, detecting means for detecting locking of said information with key, copying battery for reserving a limited electric power, and copying means for copying said information, whereby when said detecting means detects that the input information in said copying means is locked with said key, action of the copying means is enabled only if electric power is supplied from both said copying battery and power source, and the electric power proportional to the quantity of copied information is subtracted from said copying battery.

15. The signal copy protection method as defined in claim 14, wherein the copying battery is a virtual cell for storing the initial electric power proportional to the copyright fee paied at the time of purchase thereof in the form of information, and when it is used, a copy permit signal is supplied to outside as electric power, and the balance of the value proportional to the quantity of copied information from the stored electric power is stored again, and when the re-stored value becomes zero, the output of copy permit signal is stopped.

16. The signal copy protection method as defined in claim 14, wherein the copying battery is composed of a limited number of unerasable memory devices, and the detecting means writes a specified value in said memory devices by the number of times proportional to the quantity of copied information, and detects that specified value is written in all memory devices, when the action of the copying means is stopped.

17. The signal copy protection method as defined in claim 14, wherein the copying battery is a terminal machine of a bank online system, and the amount proportional to the quantity of copied information is automatically subtracted from the account of the user who has copied so as to be paid to the copyright owner.

18. The signal copy protection method as define in claim 14, wherein the detecting means and copying means are built in a one-body structure.

FIG. 1

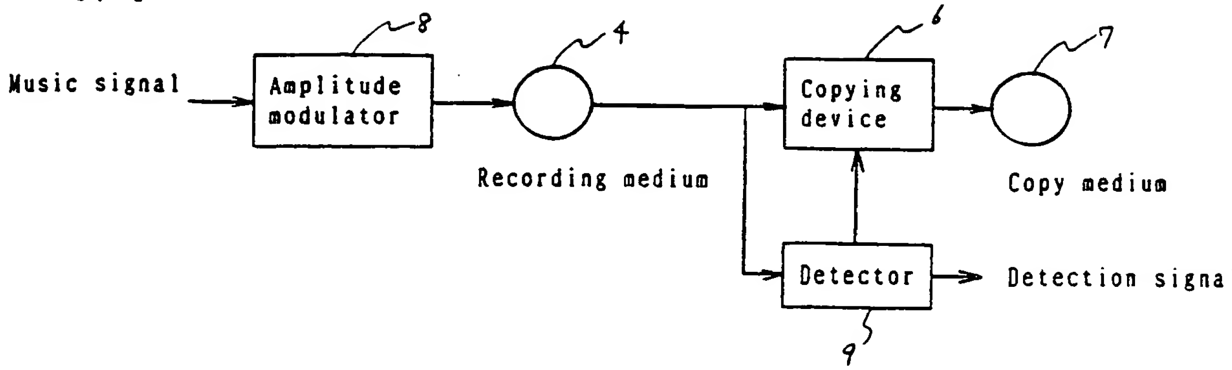


FIG. 2

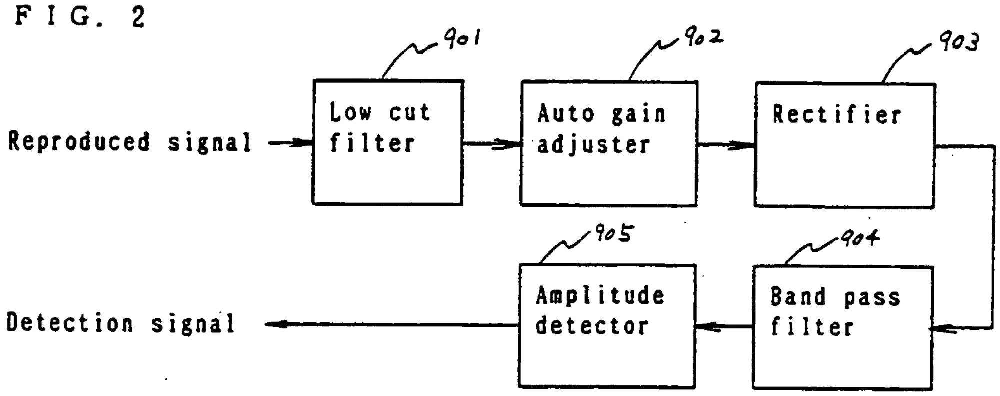


FIG. 3

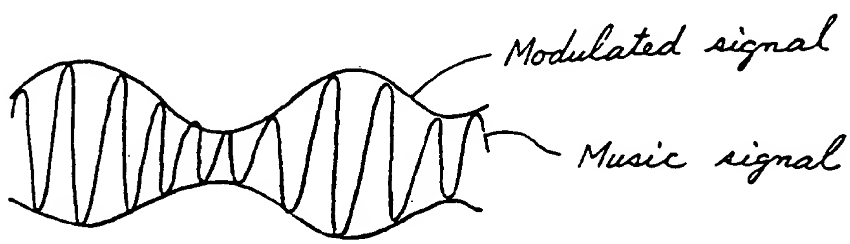


FIG. 4

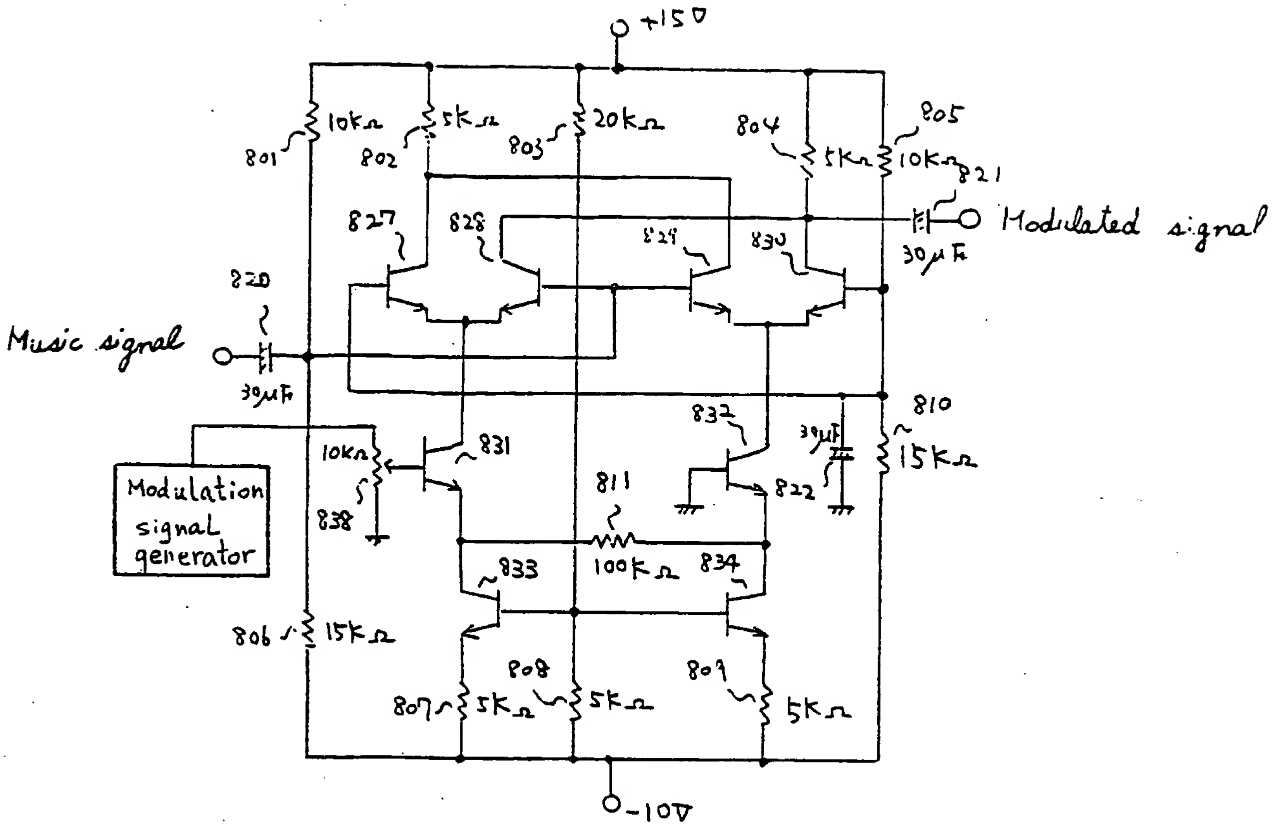

+15V
10kΩ
5kΩ
20kΩ
804
805
801
802
803
5kΩ
10kΩ
821
827
828
829
830
Modulated signal
30μF
820
Music signal
30μF
810
832
30μF
10kΩ
831
15kΩ
Modulation signal generator
811
822
838
833
100kΩ
834
806
15kΩ
808
809
807
5kΩ
5kΩ
5kΩ
-10V

FIG. 5

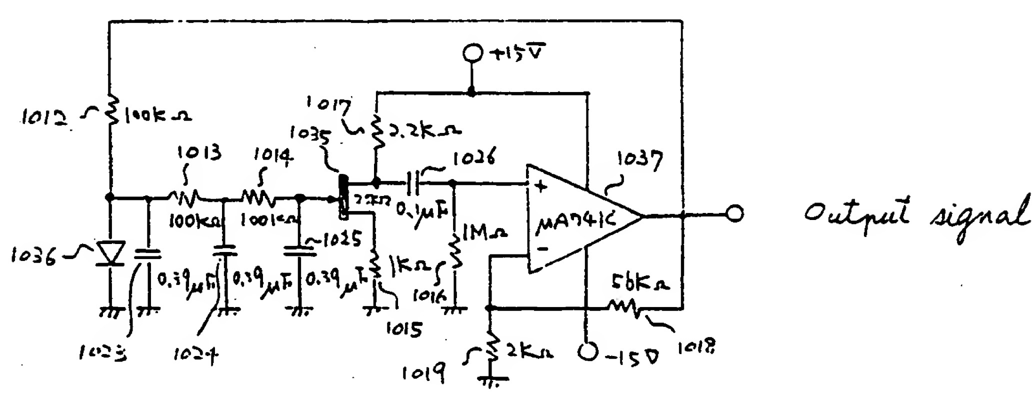

+15V
1012
100kΩ
1017
1035
2.2kΩ
1013
1014
1026
1037
100kΩ
100kΩ
0.1μF
1MΩ
μA741C
Output signal
1036
1025
0.39μF
0.39μF
0.39μF
1kΩ
1016
56kΩ
1023
1024
1015
1019
2kΩ
-15V
1018

FIG.6

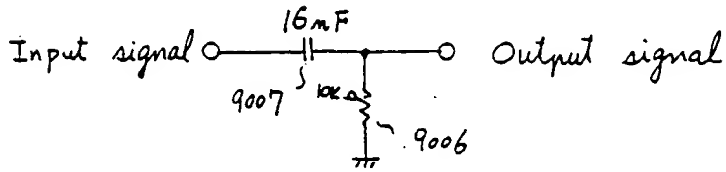


FIG.7

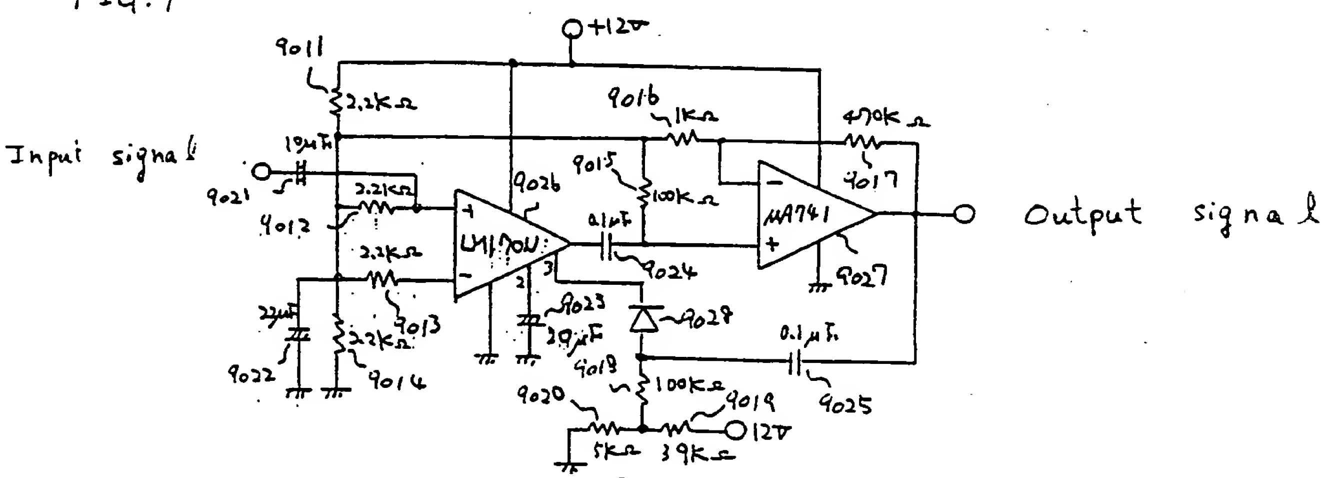


FIG.8

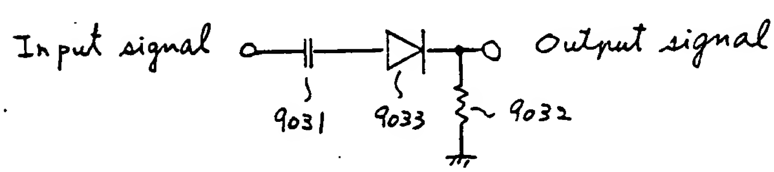


FIG.9

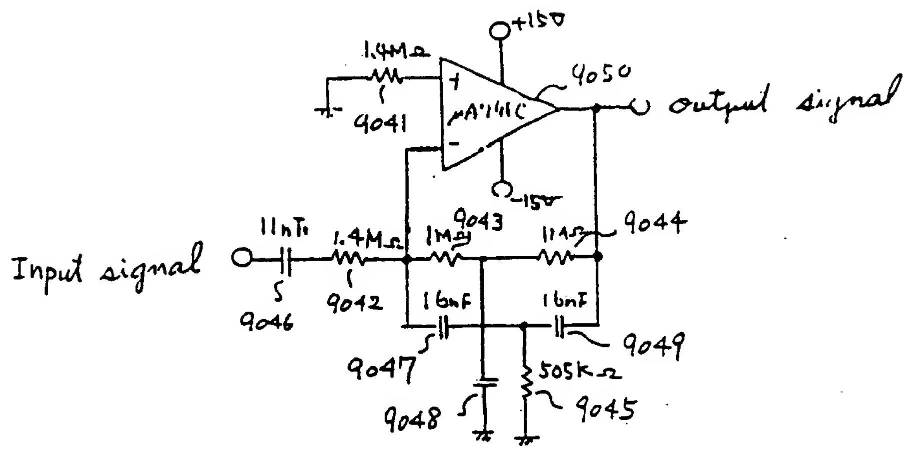


FIG.10

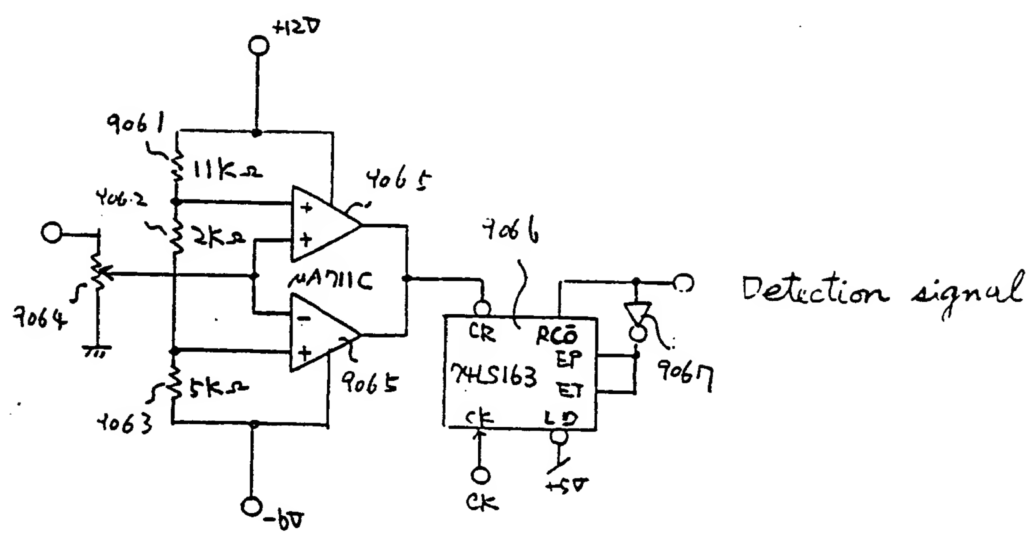
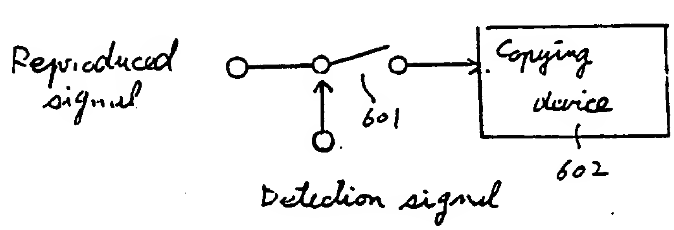
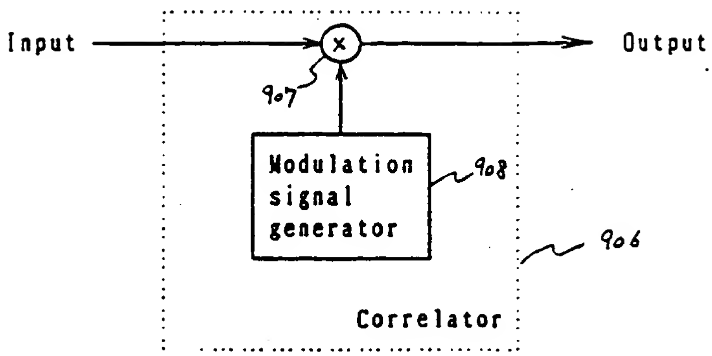


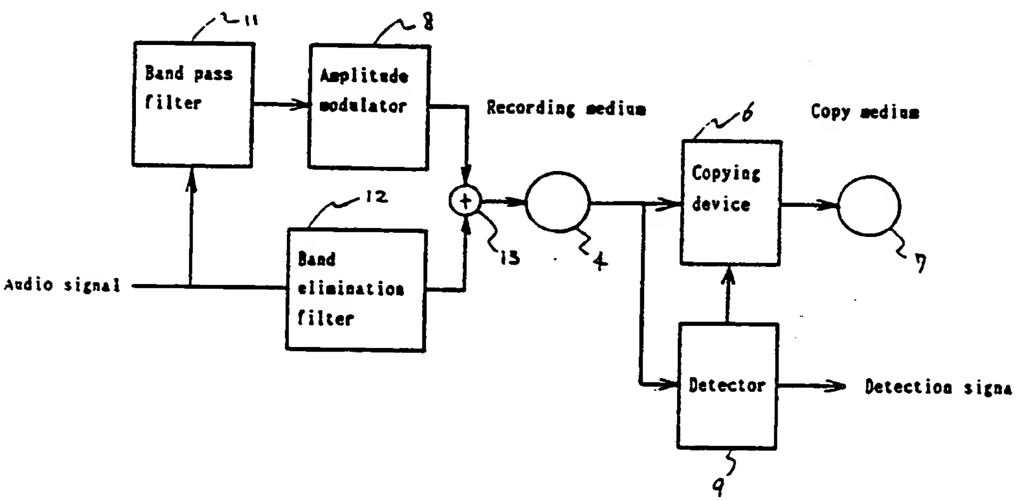
FIG. 11



F I G. 1 2



F I G. 1 3



F I G. 1 4

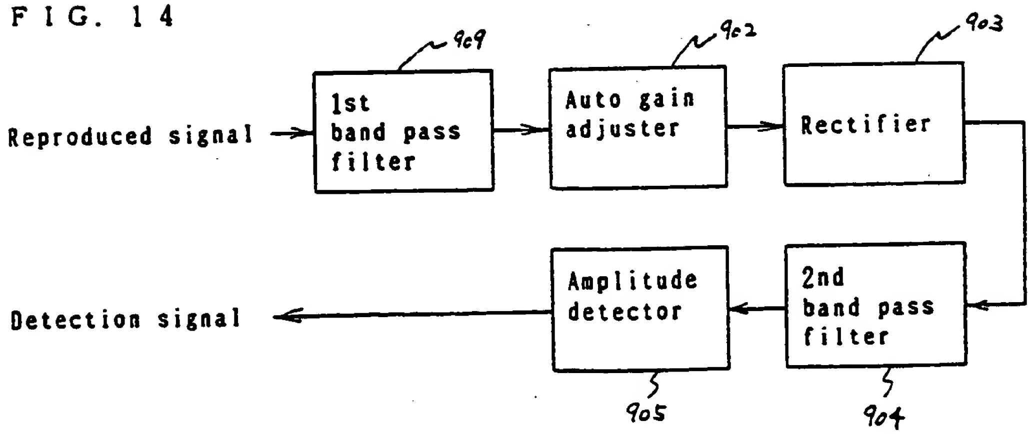


FIG. 15

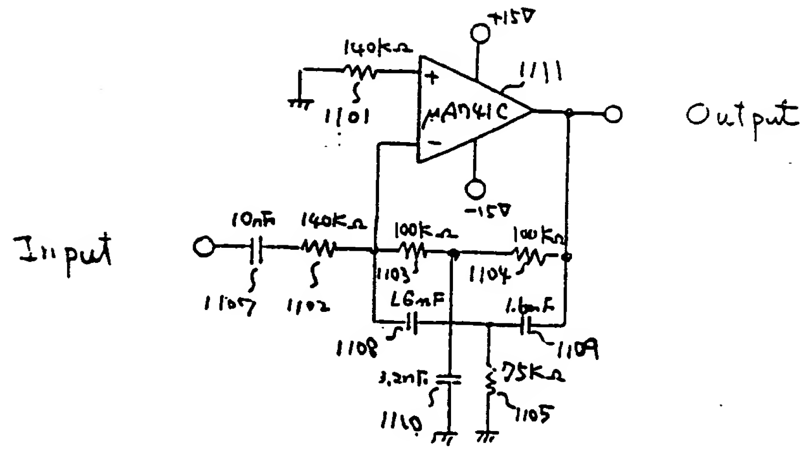


FIG. 16

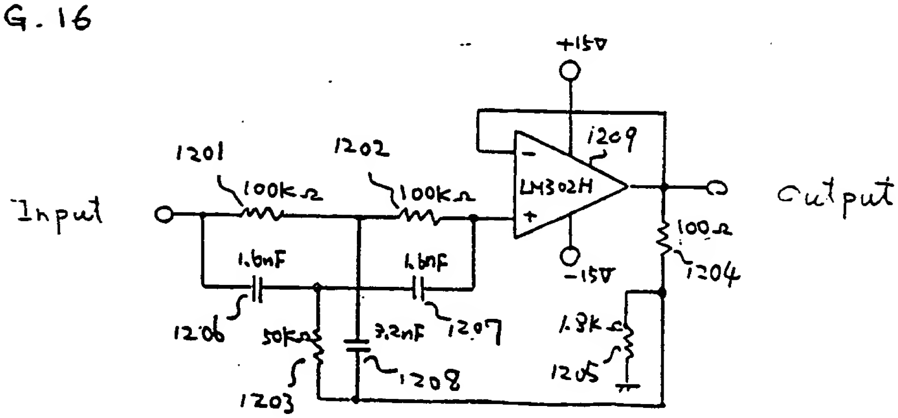


FIG. 17

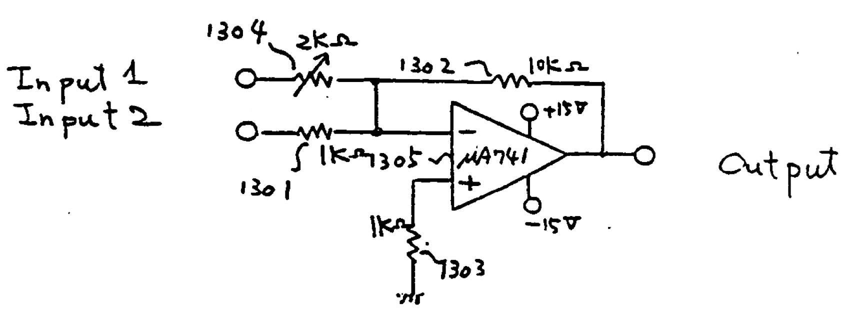
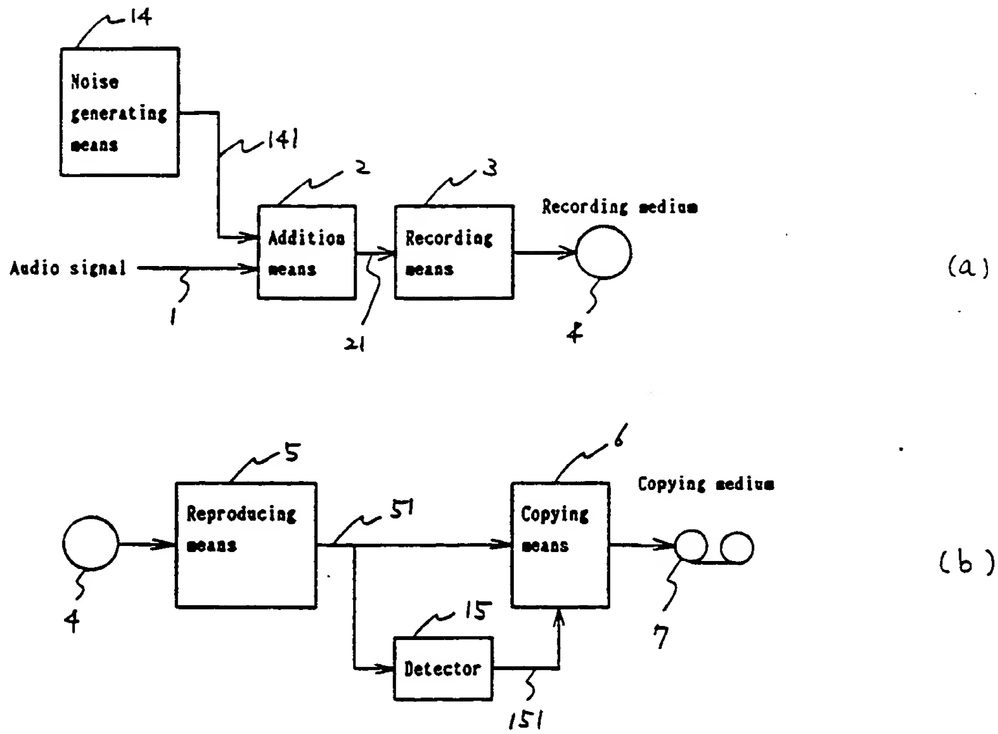
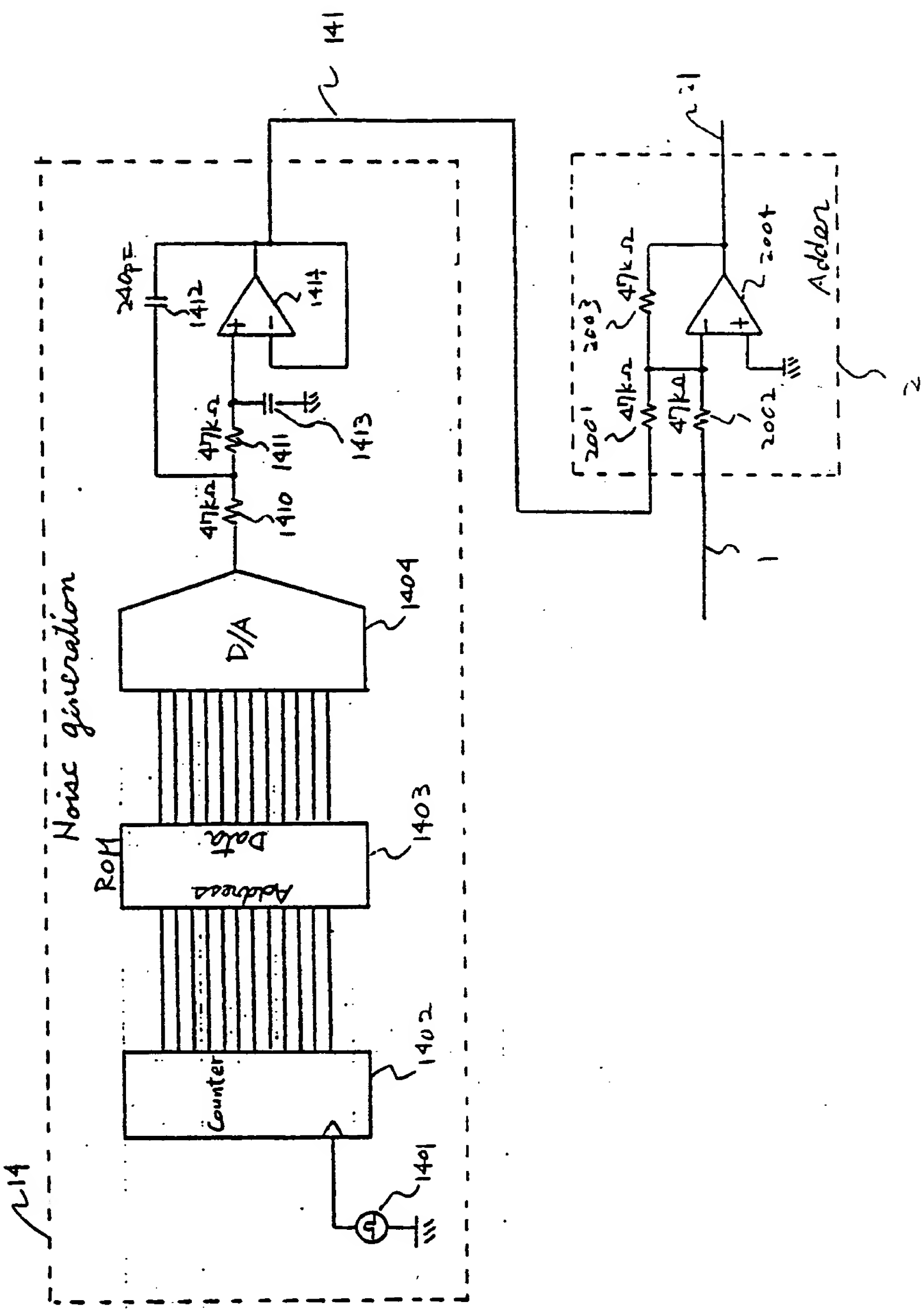


FIG. 18


14
Noise generating means
141
2
3
Recording medium
Addition means
Recording means
Audio signal
1
21
4
(a)
5
6
Copying medium
Reproducing means
51
Copying means
4
15
Detector
151
7
(b)



14
Noise generation
1401
Counter
1402
ROM
Address
Data
1403
D/A
1404
47kΩ
1410
47kΩ
1411
1413
240pF
1412
1414
141
2001
47kΩ
2002
47kΩ
2003
47kΩ
2004
Adder
2
1
21

FIG.19

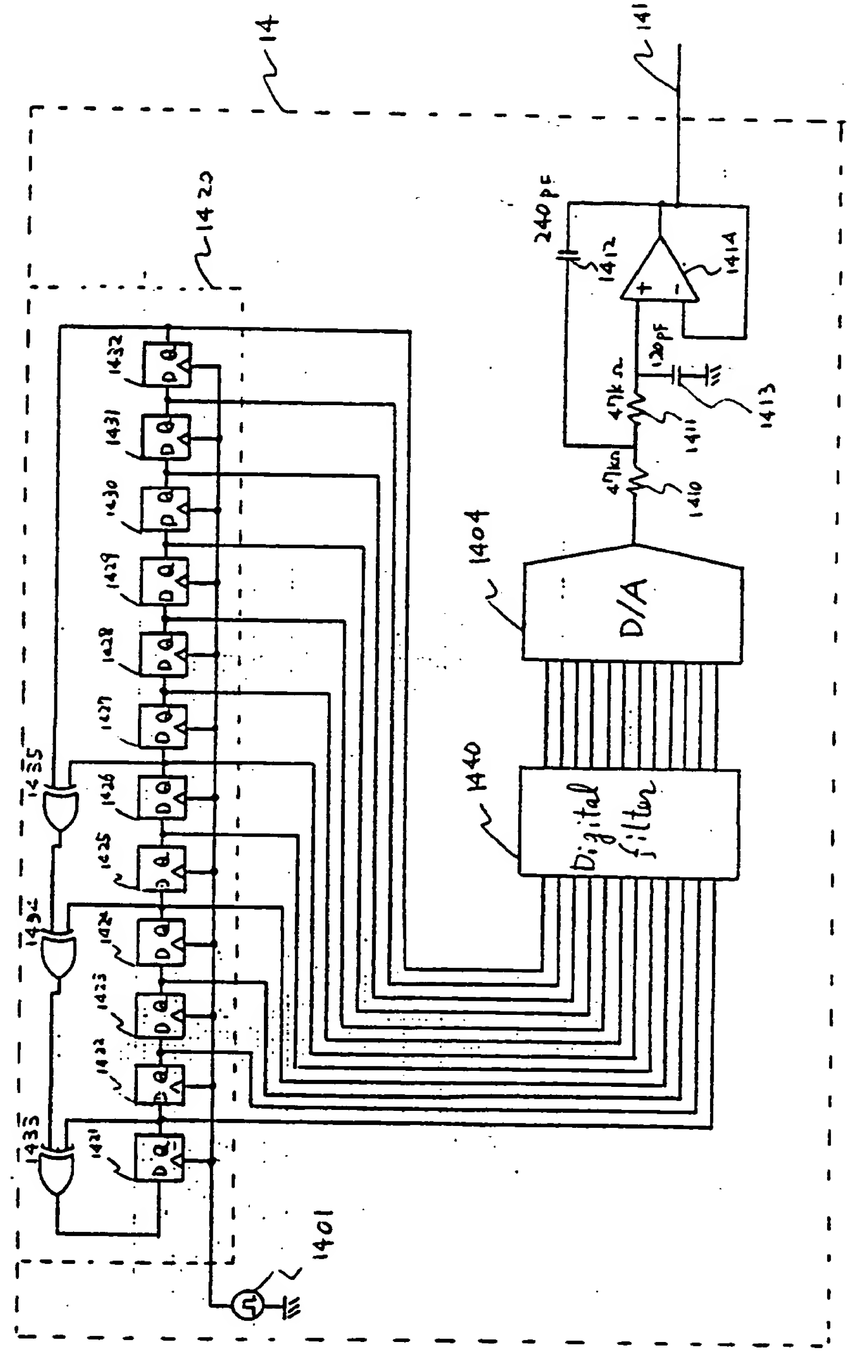

14
1420
141
240pF
1412
1414
120pF
47kΩ
1411
1413
47kΩ
1410
1404
D/A
1440
Digital filter
1421
1422
1423
1424
1425
1426
1427
1428
1429
1430
1431
1432
1433
1434
1435
1401

FIG. 20

FIG. 21

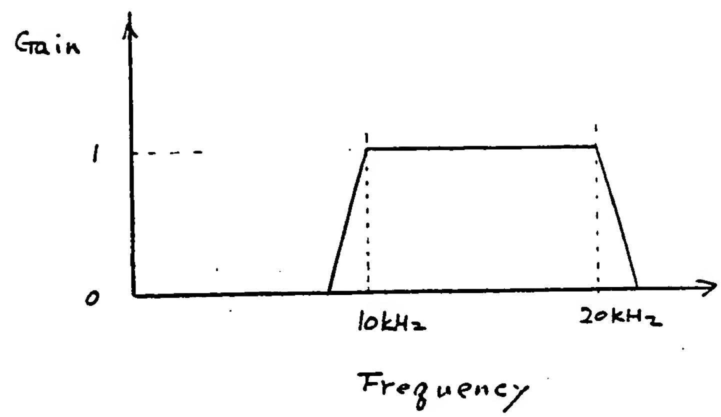

Gain
1
0
10kHz
20kHz
Frequency

FIG. 22

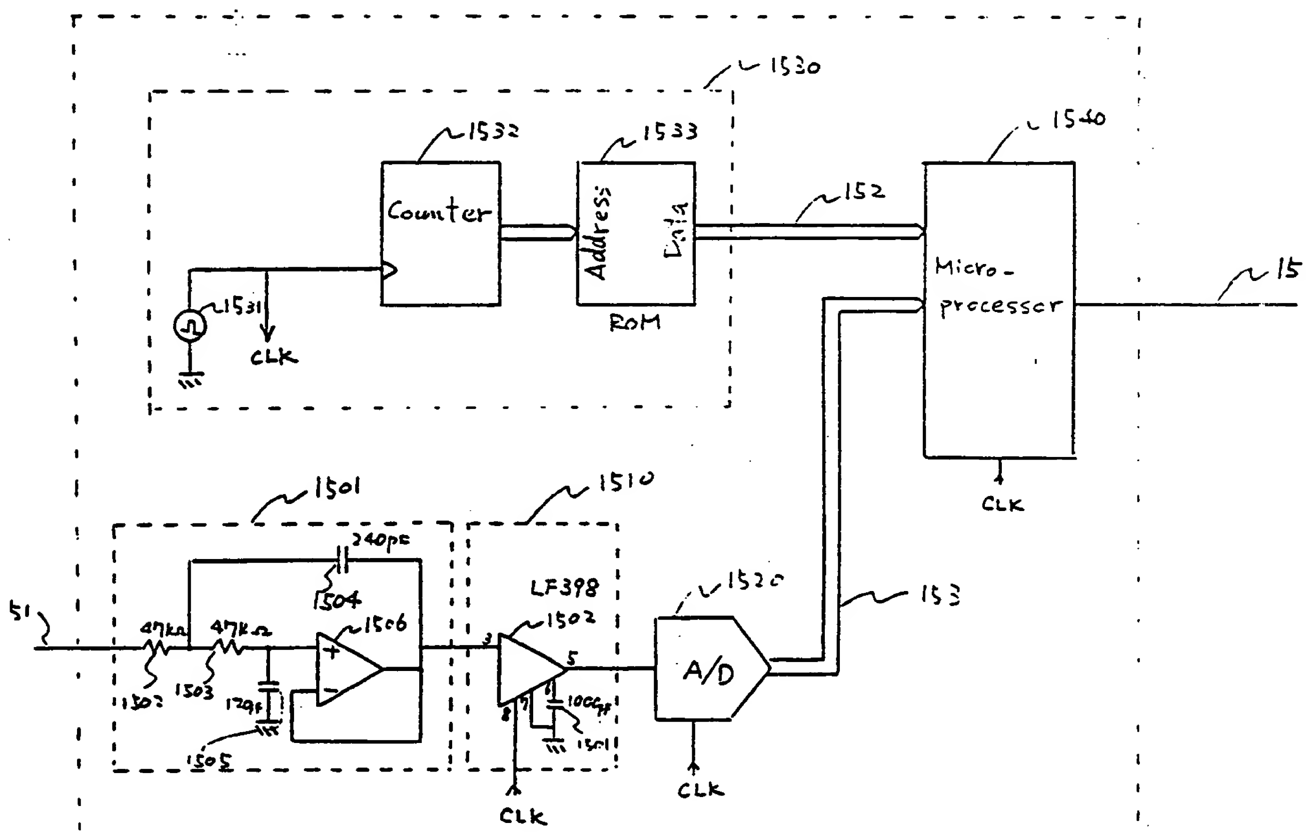

1530
1532
1533
1540
Counter
Address
Data
ROM
152
Micro-
processor
151
1531
CLK
1501
1510
240pF
1504
LF398
1520
51
47kΩ
47kΩ
1506
1502
153
A/D
1502
1503
1505
100pF
CLK
CLK
CLK

FIG. 23

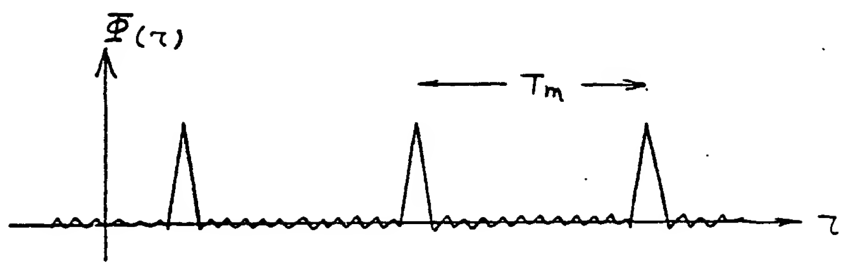


FIG. 24(a)

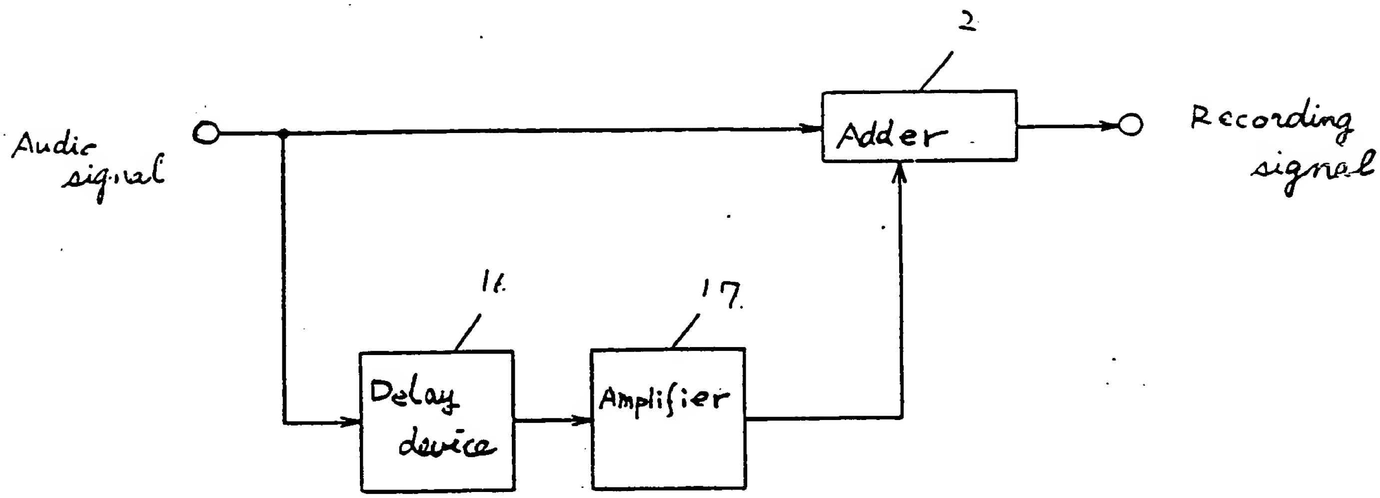


FIG. 24(b)

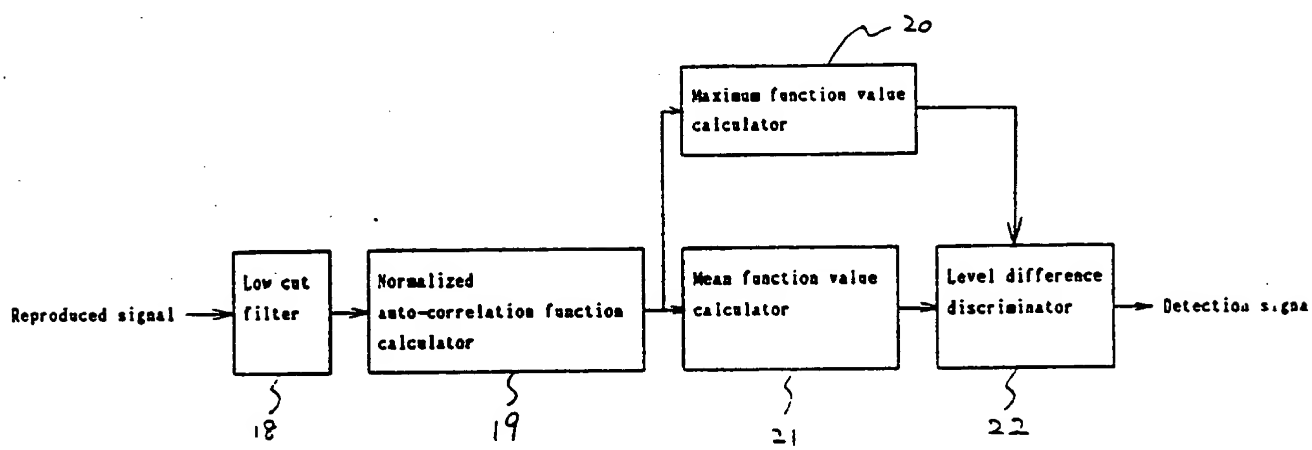


FIG. 25

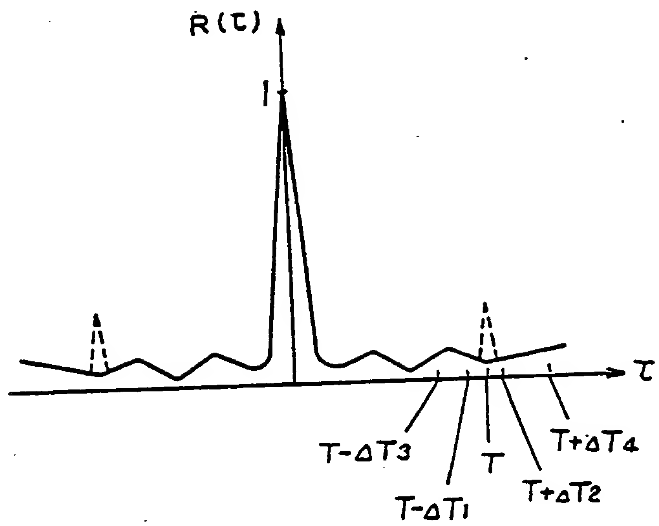
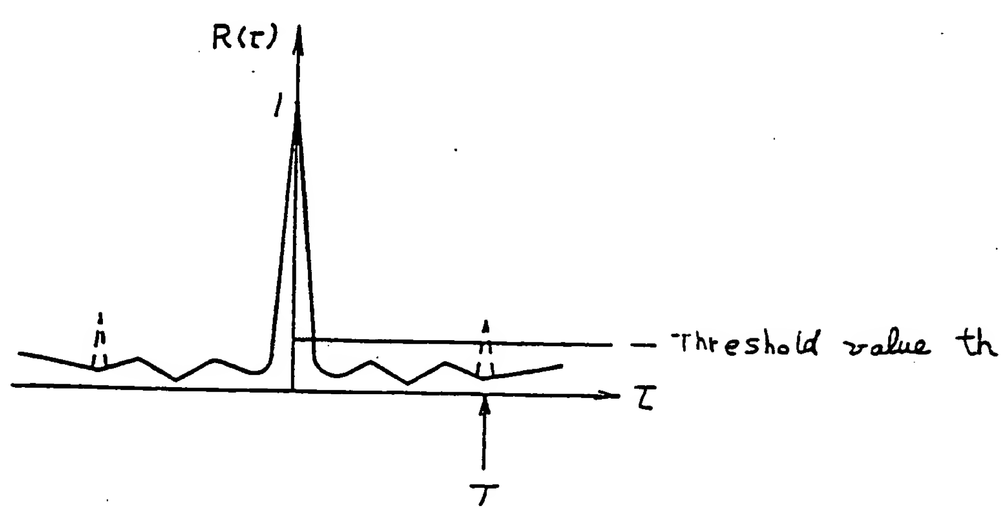
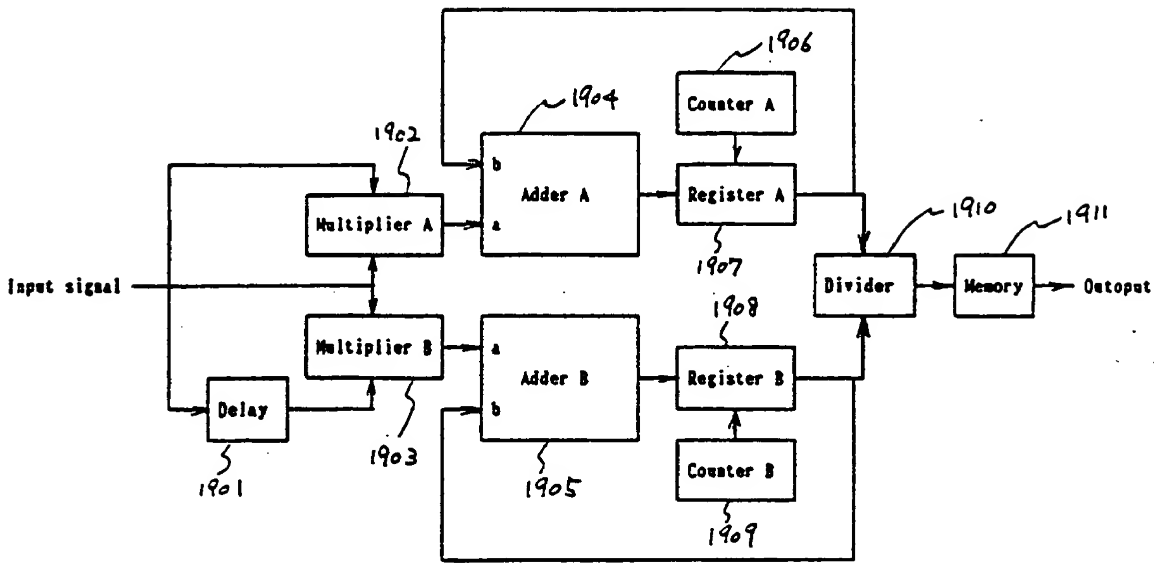


FIG. 28



F I G. 2 6


Input signal
Multiplier A
Multiplier B
Delay
Adder A
Adder B
Counter A
Register A
Register B
Counter B
Divider
Memory
Output
1901
1902
1903
1904
1905
1906
1907
1908
1909
1910
1911

F I G. 2 7

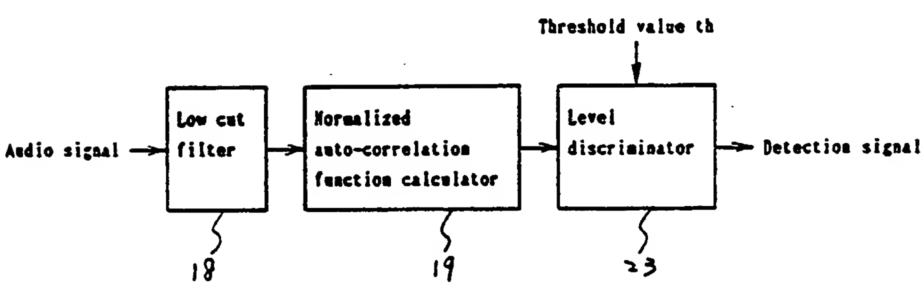

Threshold value th
Audio signal
Low cut filter
Normalized auto-correlation function calculator
Level discriminator
Detection signal
18
19
23

FIG. 29

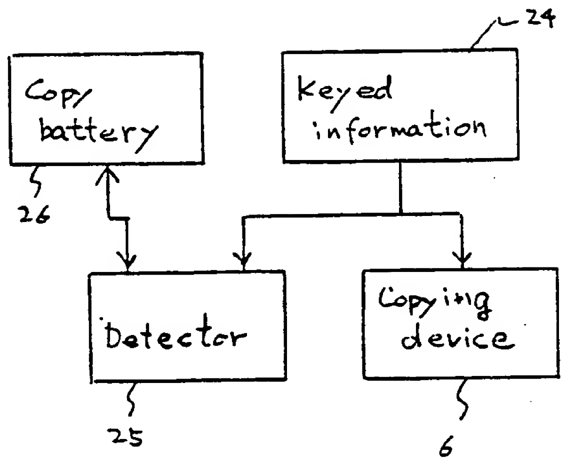


FIG. 30

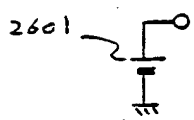


FIG. 31

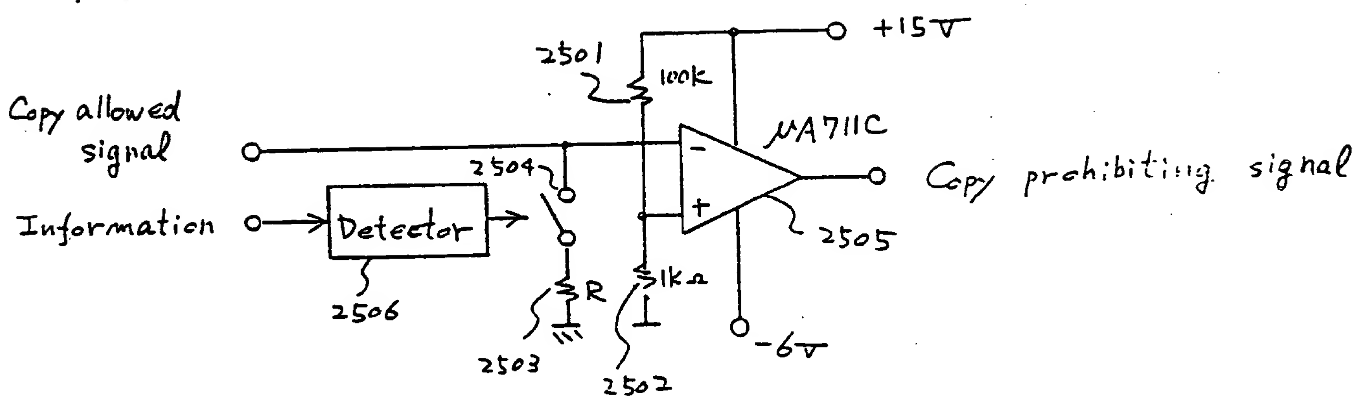


FIG. 32

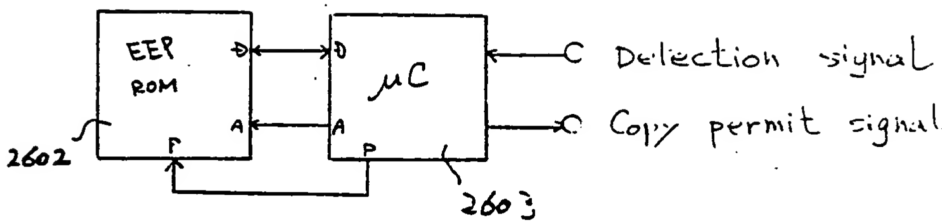
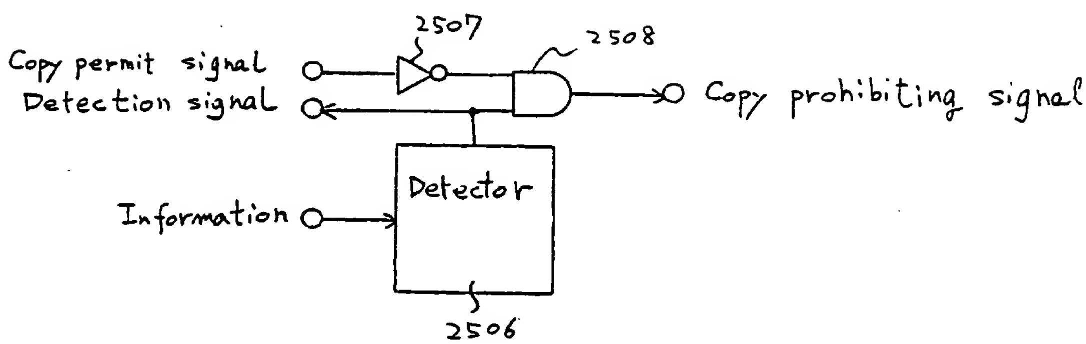

EEP ROM
D
A
P
μC
D
A
P
Detection signal
Copy permit signal
2602
2603

FIG. 33


2507
2508
Copy permit signal
Detection signal
Copy prohibiting signal
Detector
Information
2506

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 298 691 A3**

(12) # EUROPEAN PATENT APPLICATION

(21) Application number: 88306101.2

(51) Int. Cl.[5]: G11B 20/00, G11B 19/00

(22) Date of filing: 05.07.88

(30) Priority: 08.07.87 JP 170248/87
08.07.87 JP 170249/87
21.09.87 JP 236527/87
15.12.87 JP 316635/87

(43) Date of publication of application:
11.01.89 Bulletin 89/02

(84) Designated Contracting States:
DE FR GB NL

(88) Date of deferred publication of the search report:
22.08.90 Bulletin 90/34

(71) Applicant: **Matsushita Electric Industrial Co., Ltd.**
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Inventor: **Uekawa, Yutaka**
2-2-1011, Wakaba-Cho
Ashiya-shi Hyogo-ken, 659,(JP)
Inventor: **Senou, Takanori**
1-24-8, Higashinakaburi
Hirakata-shi Osaka-fu, 573,(JP)
Inventor: **Takahashi, Kenichi** 381-6 Enoki-cho
Kuromondourinakadachiuri-sagaru
Kamigyo-ky Kyoto-shi Kyoto-fu, 602,(JP)

(74) Representative: **Crawford, Andrew Birkby et al**
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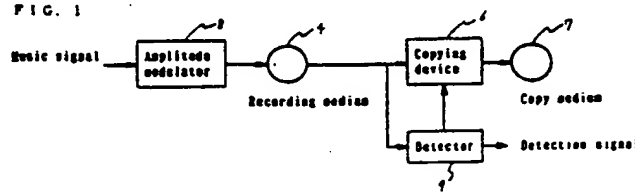
London WC1V 7LE(GB)

(54) **Method and apparatus for protection of signal copy.**

(57) This invention relates to a method and apparatus for protection of signal copy for preventing unauthorized copy of music software such as record, compact disc and music tape by recording. More particularly, when manufacturing the music software, that is, when recording audio signals into the medium, certain supplemental information is added to the audio signal to be recorded, and in the process of copying by reproducing this medium, when the supplemental signal is detected in the reproduced signal, the copying action is stopped to protect from copy, so that the music software of which copy is prohibited is protected from being copied.

FIG. 1



EP 0 298 691 A3

European Patent Office

EUROPEAN SEARCH REPORT

Application number
EP 88 30 6101

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
X Y	PATENT ABSTRACTS OF JAPAN, vol.9, no. 116 (P-357)(1939), May 21, 1985, & JP-A-60 1660 (MITSUBISHI DENKI K.K.) 07-01-1985 * Whole document *	1 1-7	G 11 B 20/00 G 11 B 20/10 G 11 B 19/00
P,Y	GB-A-2 196 167 (THORN EMI PLC) * Whole document *	1-7	
X	PATENT ABSTRACTS OF JAPAN, vol. 10, no. 312 (P-509)(2368) October 23, 1986 & JP-A-61 123 026 (MATSUSHITA ELECTRIC IND. CO. LTD.) 10-06-1986 * Whole document *	8	
X	EXTENDED ABSTRACTS/SPRING MEETING 88-1, May 15-20, 1988, pages 202-203, abstract no. 135, Princeton, NY, US H.-H. CHEN et al.: "Gated isolation structure for high density, high speed radiation-hardened bulk CMOS technology" * Whole document *	1,8-11	TECHNICAL FIELDS SEARCHED (Int. Cl.4) G 11 B H 04 N G 06 F G 07 F
Y	GB-A-1 567 333 (ROBERT HUGHES) * Whole document *	14-17	
Y	EP-A-0 107 286 (BLONDER-TONGUE LAB.) * Whole document *	14-17 ./.	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	11-05-1990	DEVERGRANNE

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons
& : member of the same patent family, corresponding document

European Patent Office

CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing more than ten claims.

- [ ] All claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for all claims.
- [ ] Only part of the claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims and for those claims for which claims fees have been paid.

  namely claims:
- [ ] No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirement of unity of invention and relates to several inventions or groups of inventions.

namely:

1. Claims 1-13: Signal copy protection method and apparatus
2. Claims 14-18: Limited copy of information corresponding to a predetermined copyright fee loaded initially

- [x] All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.
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  namely claims:

European Patent Office

EUROPEAN SEARCH REPORT

Application number
EP 88 30 6101
-2-

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl 4)
A	GB-A-2 104 701 (JAMES BERTRAM KING) * Whole document * --	1	
A	GB-A-2 050 675 (JOHN ANTONY DIMMERS)		
A	GB-A-2 162 992 (EDWARD PETER SINGTON)		
A	US-A-4 632 335 (EDWARD DICKSON)		
A	EP-A-0 140 705 (R.F. MONOLITHICS)		
A	GB-A-1 166 085 (SCHEIDT & BACKMANN) --------		
			TECHNICAL FIELDS SEARCHED (Int. Cl 4)

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& : member of the same patent family, corresponding document

FIG. 9

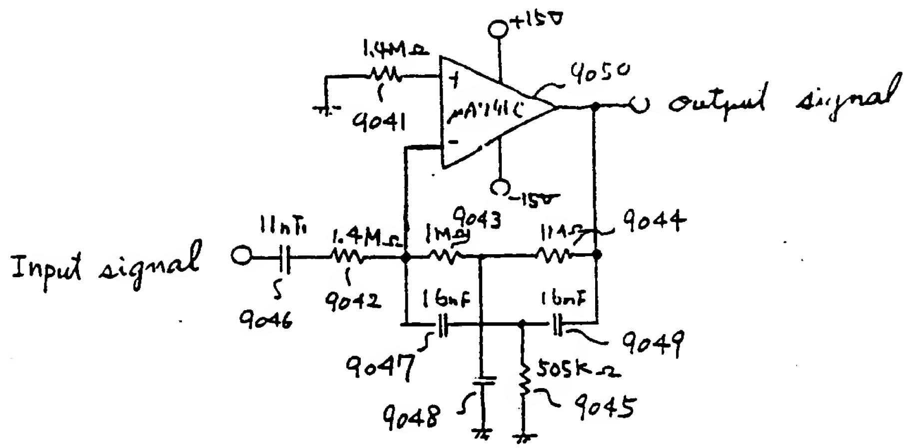


FIG. 10

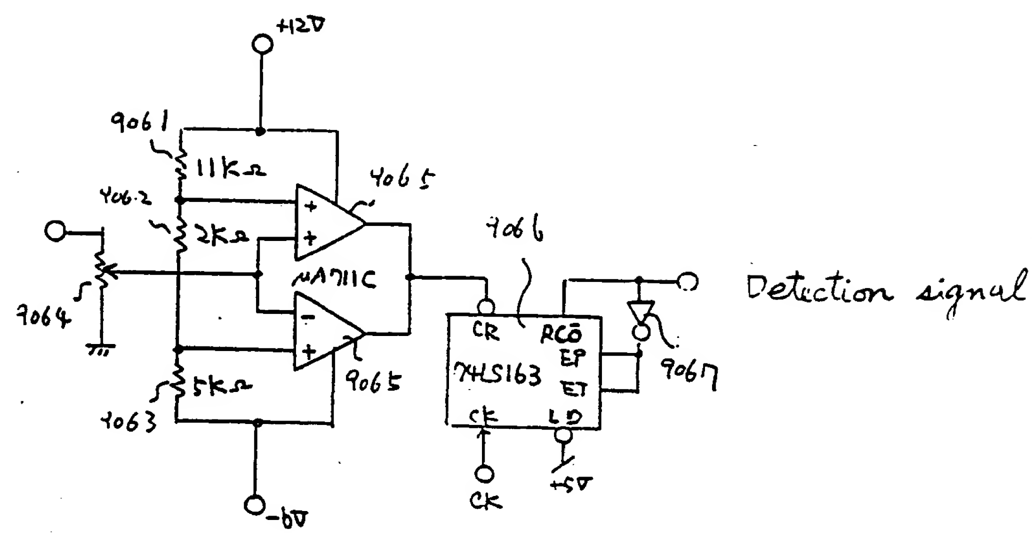


FIG. 11

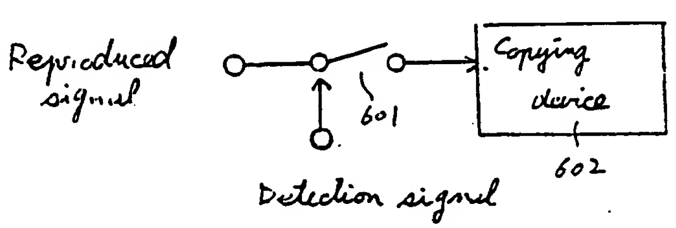


FIG. 12

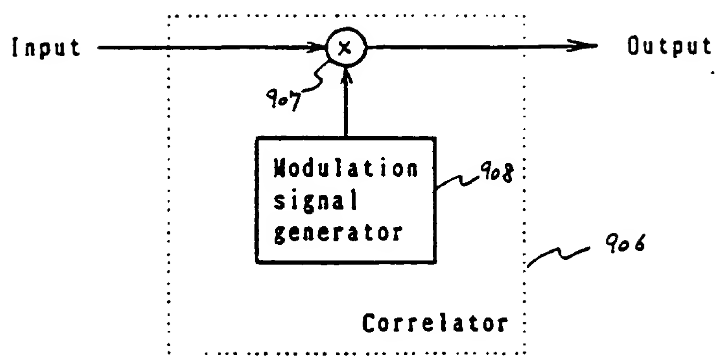


FIG. 13

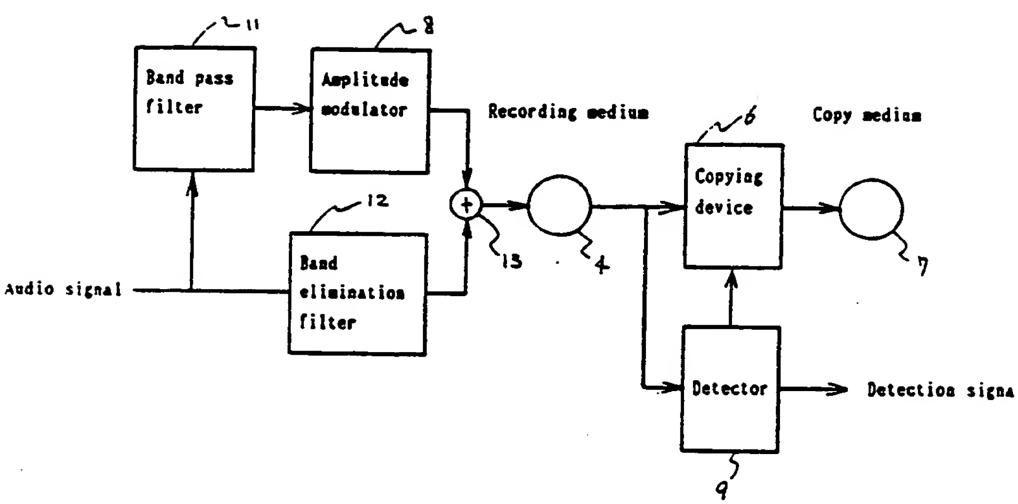


FIG. 14

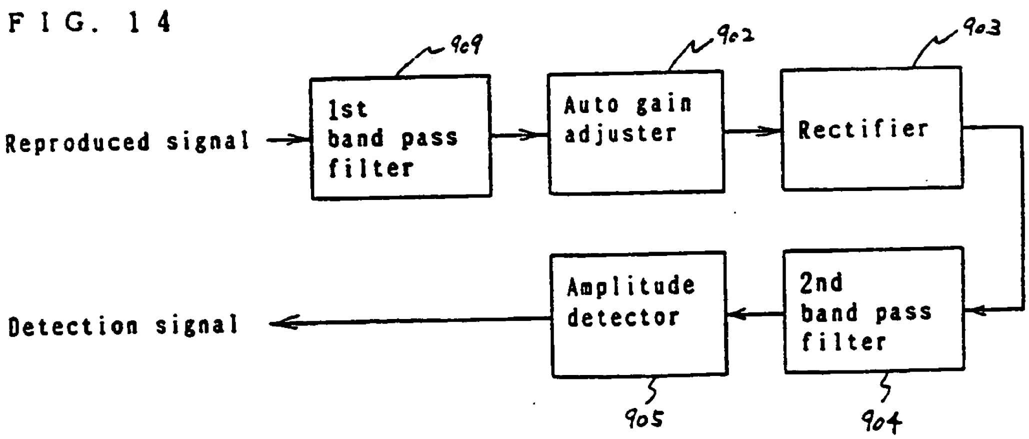


FIG. 15

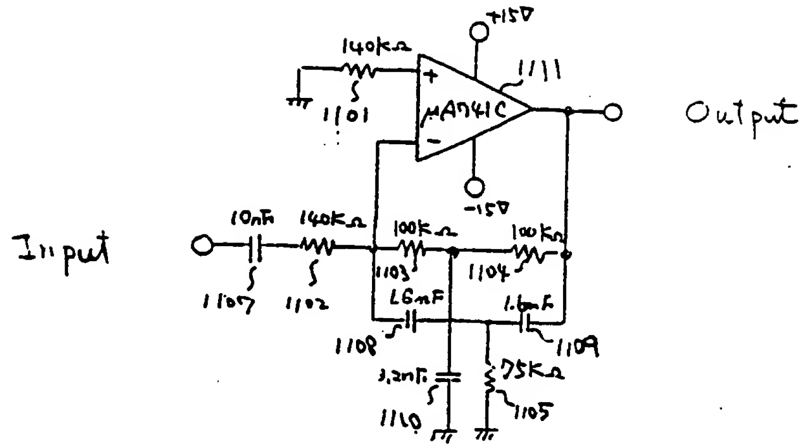


FIG. 16

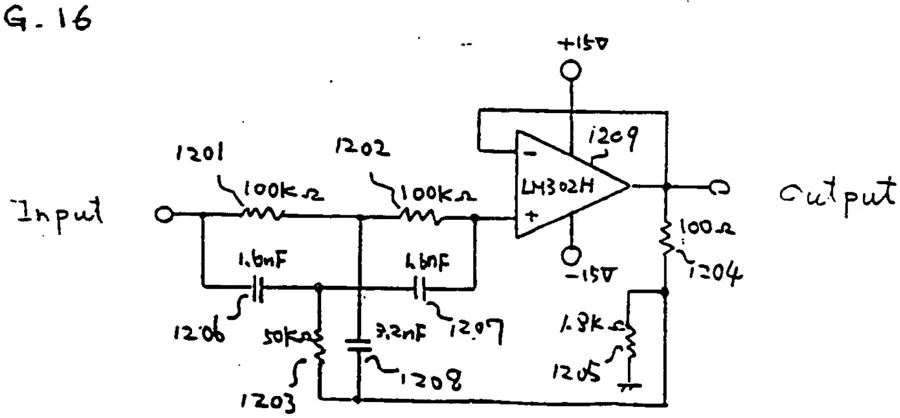
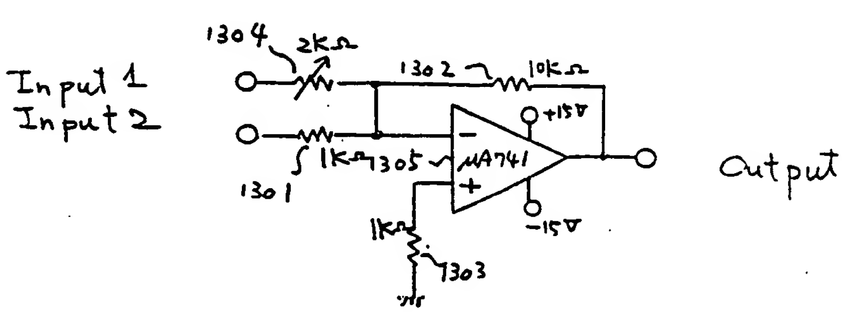
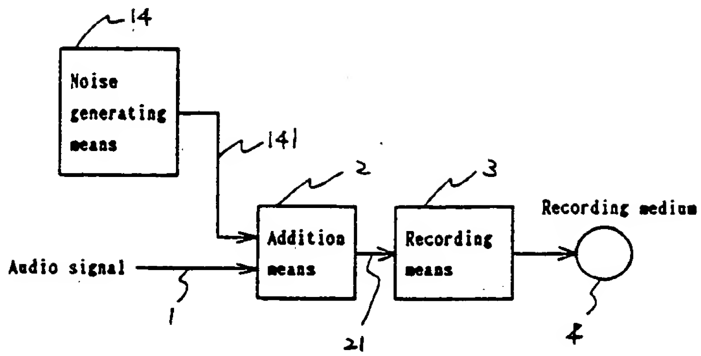


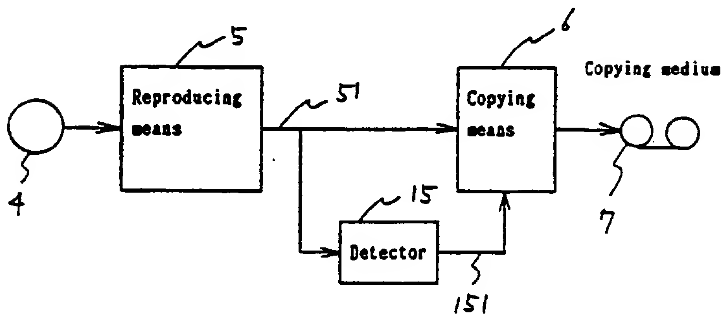
FIG. 17



F I G. 1 8


14
Noise generating means
141
2
3
Addition means
Recording means
Recording medium
Audio signal
1
21
4

(a)


5
6
Reproducing means
51
Copying means
Copying medium
4
15
Detector
7
151

(b)

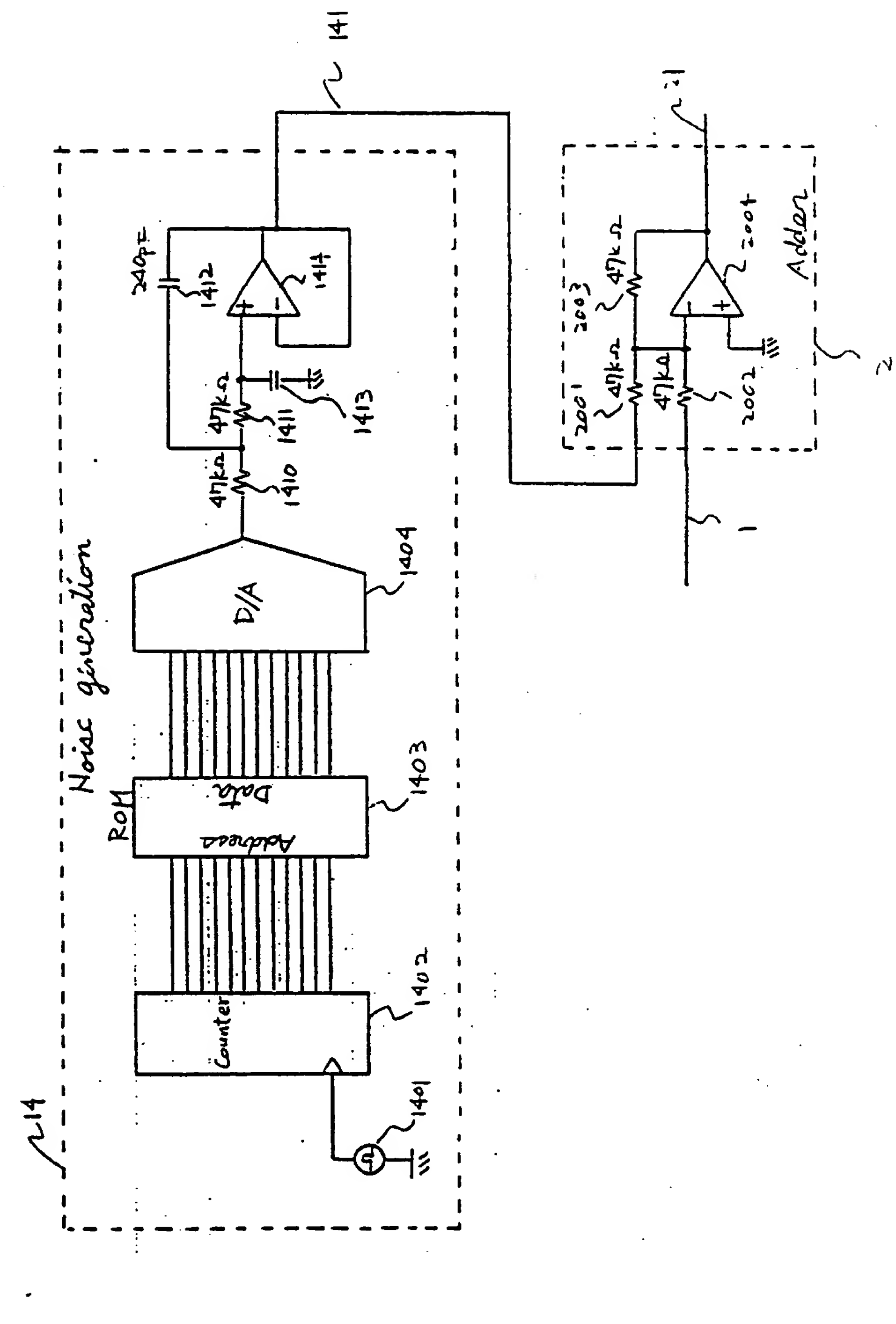

Noise generation
Counter
ROM
Address
Data
D/A
Adder
141
14
1401
1402
1403
1404
1410
1411
1412
1413
1414
47kΩ
47kΩ
240pF
2001
2002
2003
2004
47kΩ
47kΩ
47kΩ
1
2

FIG.19

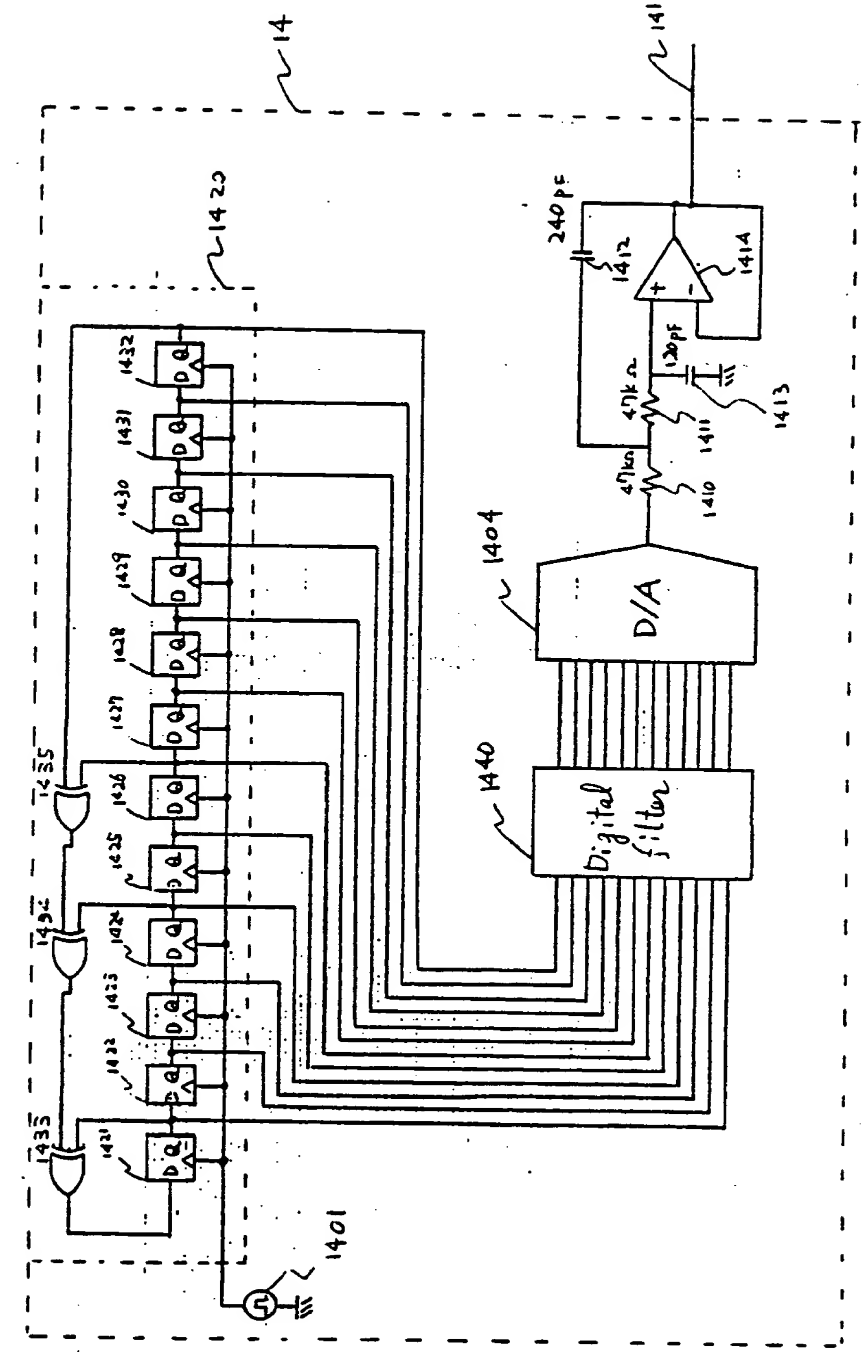

14
1420
240pF
1412
1414
141
120pF
47kΩ
1413
1411
1410
1404
D/A
1440
Digital filter
1401
1421
1422
1423
1424
1425
1426
1427
1428
1429
1430
1431
1432
1433
1434
1435

FIG. 20

FIG. 21

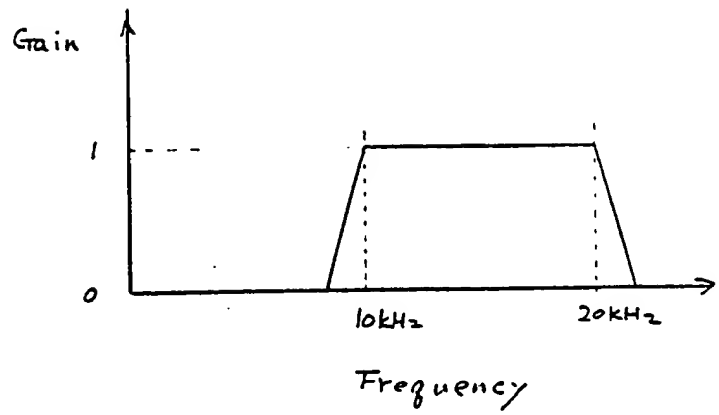

Gain
1
0
10kHz
20kHz
Frequency

FIG. 22

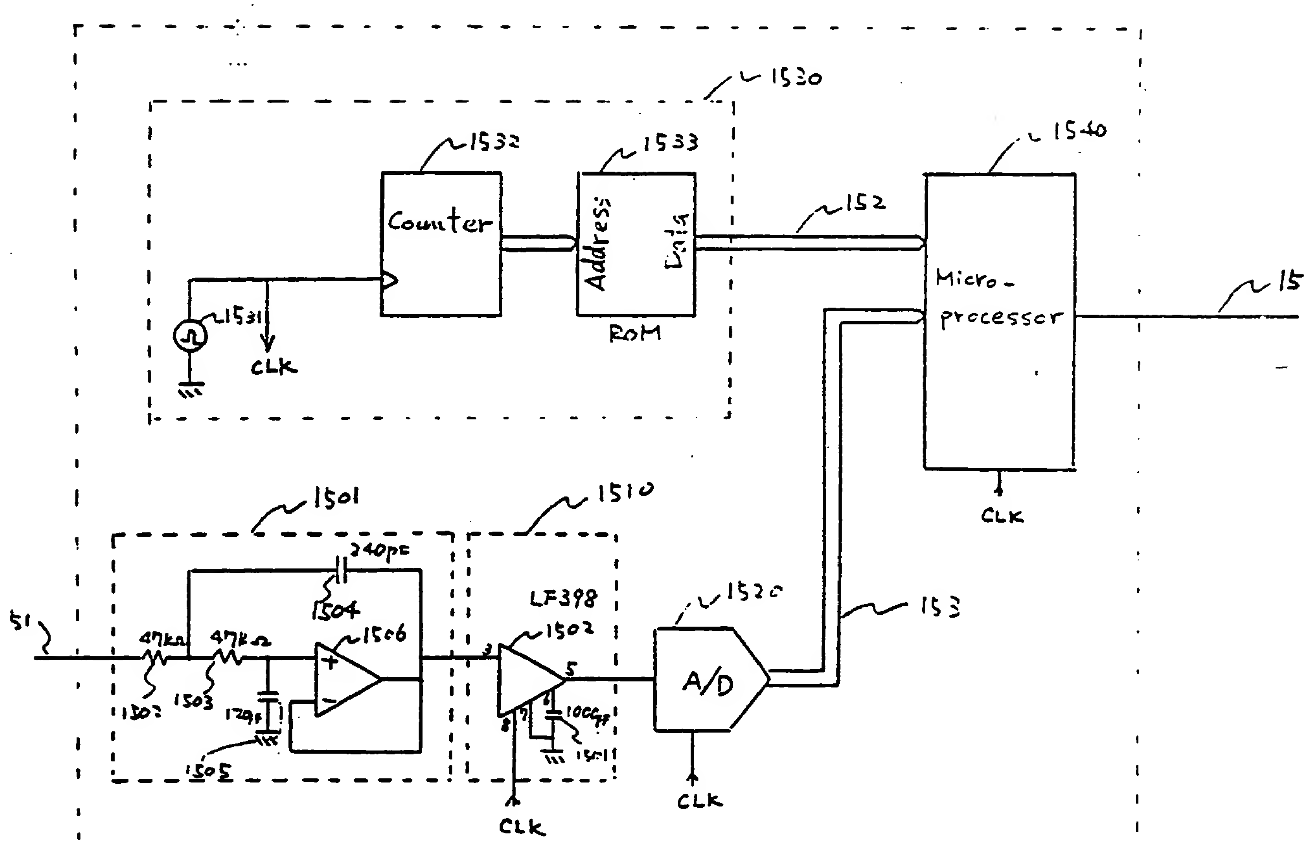

1530
1532
1533
1540
Counter
Address
Data
ROM
152
Micro-
processor
151
1531
CLK
CLK
1501
1510
240pF
1504
1506
LF398
1502
1520
153
51
47kΩ
47kΩ
1502
1503
1505
A/D
CLK
CLK

FIG. 23

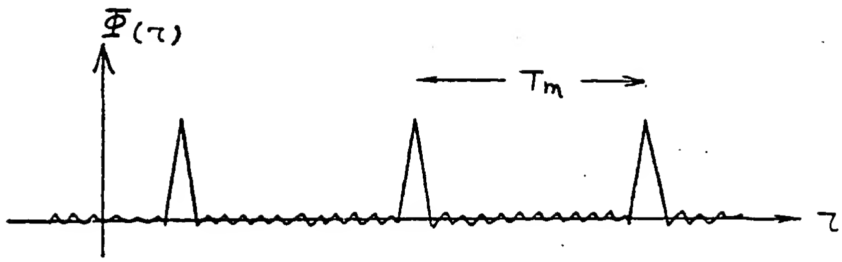


FIG. 24(a)

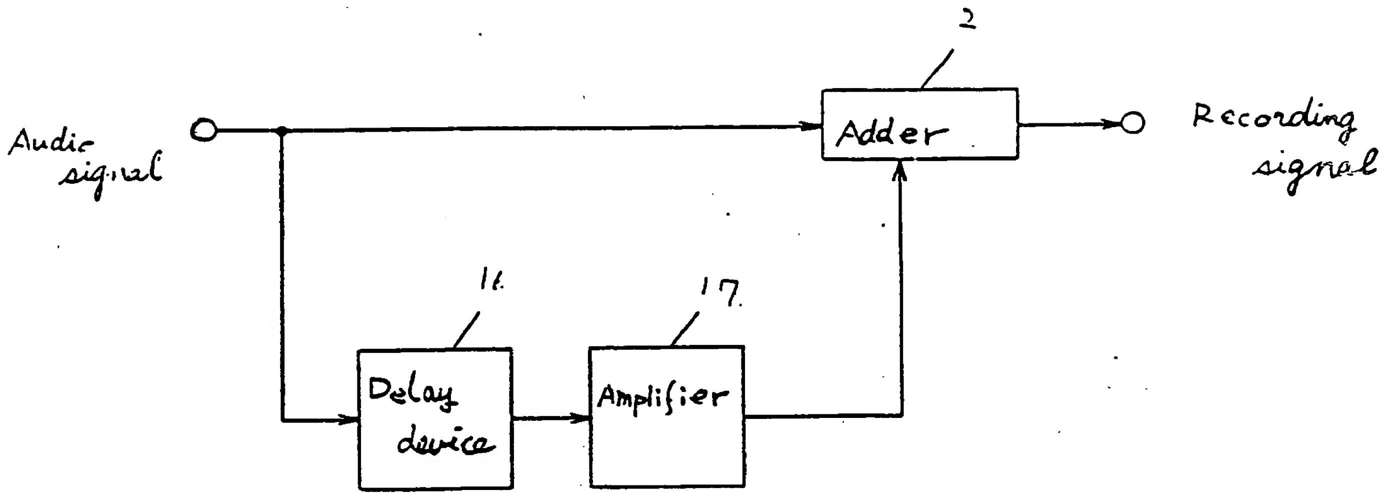


FIG. 24(b)

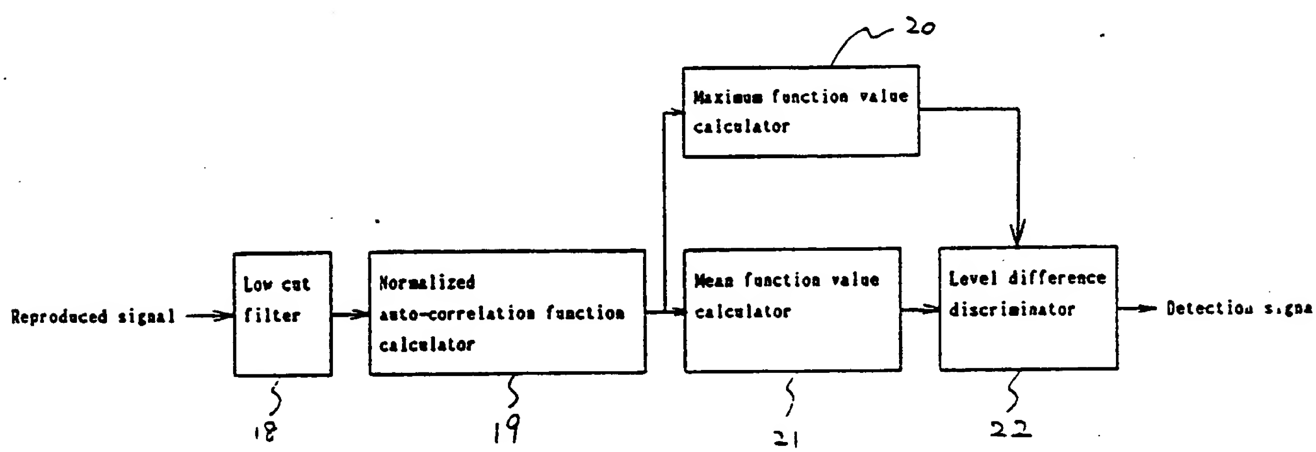


FIG. 25

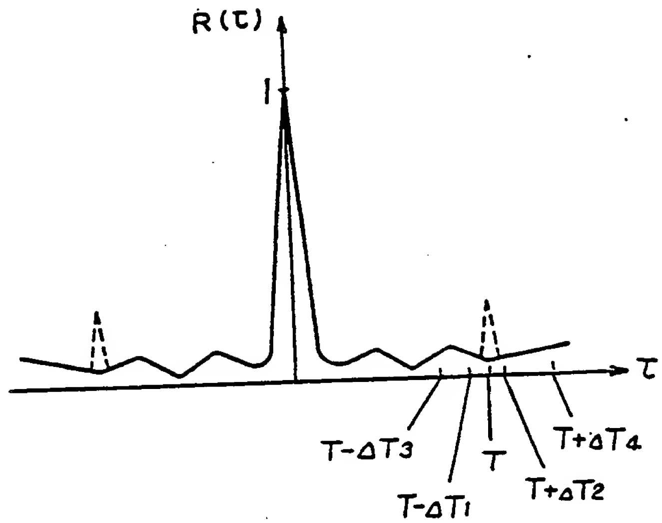
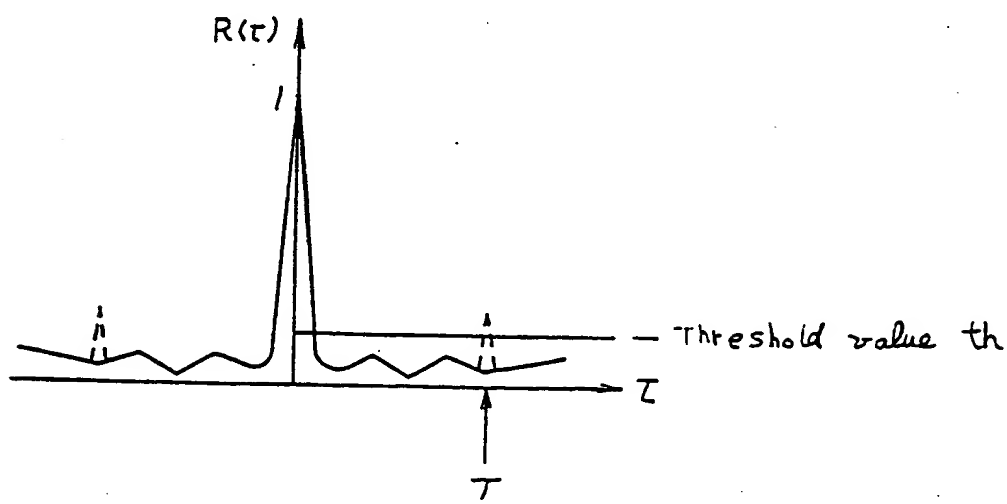
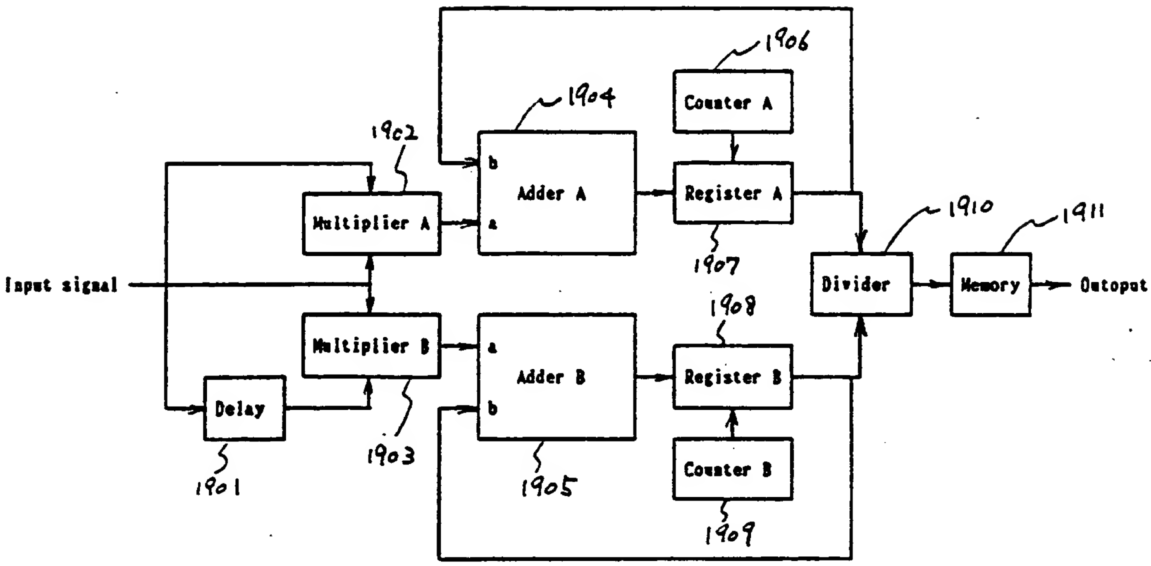


FIG. 28

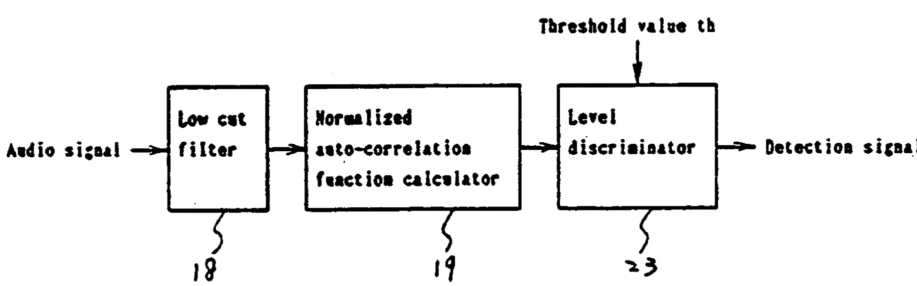


F I G. 2 6



Input signal
Delay
Multiplier A
Multiplier B
Adder A
Adder B
Counter A
Register A
Register B
Counter B
Divider
Memory
Output
a
b
a
b
1901
1902
1903
1904
1905
1906
1907
1908
1909
1910
1911

F I G. 2 7



Threshold value th
Audio signal
Low cut filter
Normalized auto-correlation function calculator
Level discriminator
Detection signal
18
19
23

FIG. 29

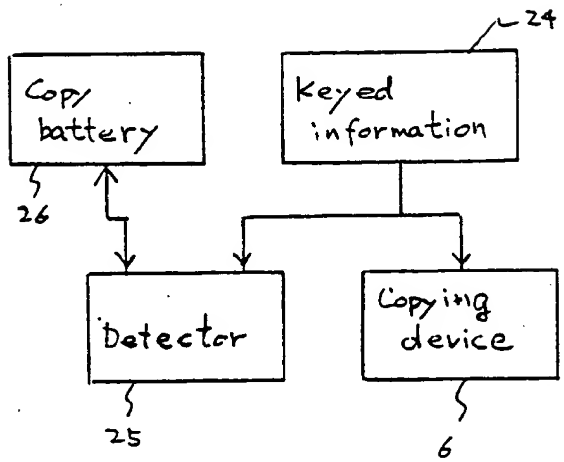


FIG. 30

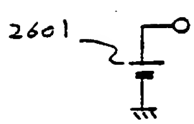


FIG. 31

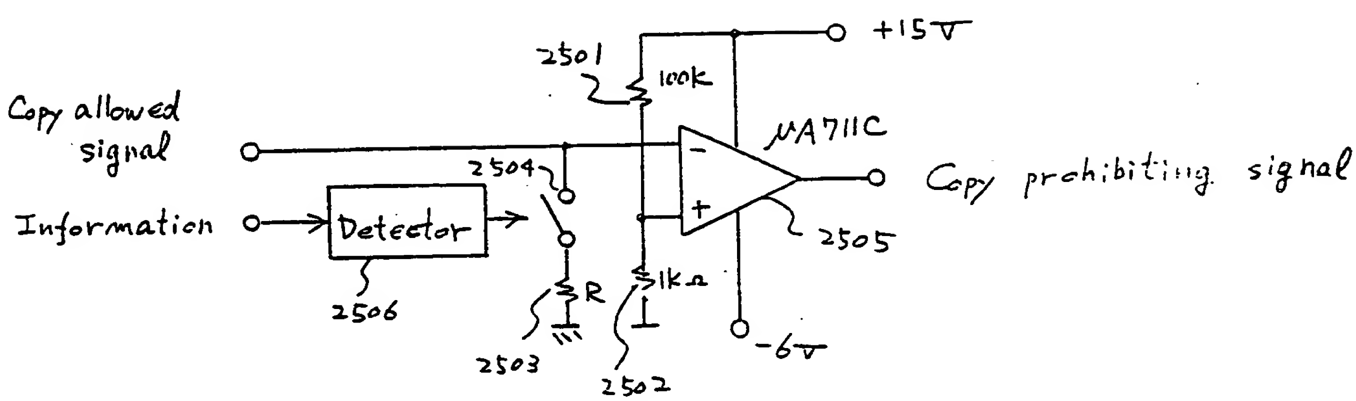


FIG. 32

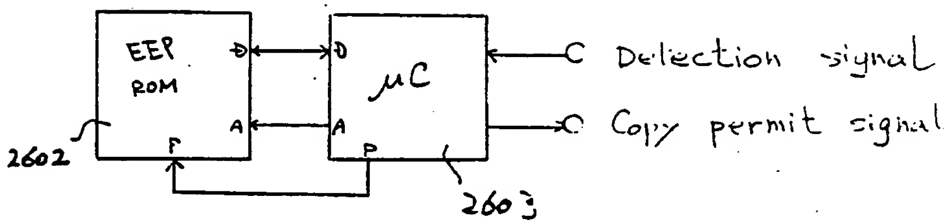
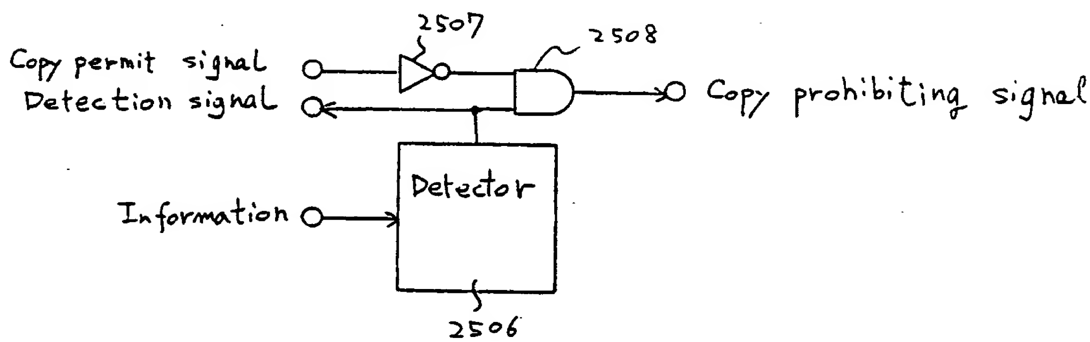

EEP ROM
D
A
P
μC
D
A
P
Detection signal
Copy permit signal
2602
2603

FIG. 33


2507
2508
Copy permit signal
Detection signal
Copy prohibiting signal
Detector
Information
2506

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(43) Date of publication of application:
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(71) Applicant: Matsushita Electric Industrial Co., Ltd.
1006, Oaza Kadoma
Kadoma-shi Osaka-fu, 571(JP)

(72) Inventor: Nagata, Atsushi
9-11 D45-501 Kourigaoka
Hirakata-shi Osaka-fu, 573,(JP)
Inventor: Uekawa, Yutaka
2-2-1011, Wakaba-Cho
Ashiya-shi Hyogo-ken, 659,(JP)
Inventor: Senou, Takanori
1-24-8, Higashinakaburi
Hirakata-shi Osaka-fu, 573,(JP)
Inventor: Takahashi, Kenichi 381-6 Enoki-cho
Kuromondourinakadachiuri-sagaru
Kamigyo-ky Kyoto-shi Kyoto-fu, 602,(JP)

(74) Representative: Crawford, Andrew Birkby et al
A.A. THORNTON & CO. Northumberland
House 303-306 High Holborn
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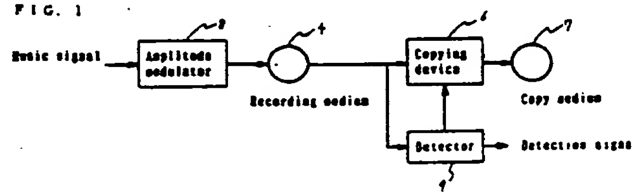

EP 0 298 691 A3

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EUROPEAN SEARCH REPORT

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DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl 4)
A	GB-A-2 104 701 (JAMES BERTRAM KING) * Whole document *	1	
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A	GB-A-2 050 675 (JOHN ANTONY DIMMERS)		
A	GB-A-2 162 992 (EDWARD PETER SINGTON)		
A	US-A-4 632 335 (EDWARD DICKSON)		
A	EP-A-0 140 705 (R.F. MONOLITHICS)		
A	GB-A-1 166 085 (SCHEIDT & BACKMANN)		

			TECHNICAL FIELDS SEARCHED (Int. Cl 4)

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
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P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document